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ABSTRACT

This curriculum guide is for administrators and their advisors to use in meeting local, state, and regional needs in training architectual and building construction technicians at the post-high school level. It was developed by a technical education specialist at the national level. The guide provides: (1) a suggested curriculum plan, (2) course outlines with examples of texts and references, (3) a sequence of technical education procedures, (4) laboratory layouts with equipment costs, (5) a discussion of the library and its use, faculty and student services, and (6) a selected list of scientific, trade, and technical societies concerned with the technology. The document is illustrated with line drawings and photographs. A bibliography is appended. (GR)

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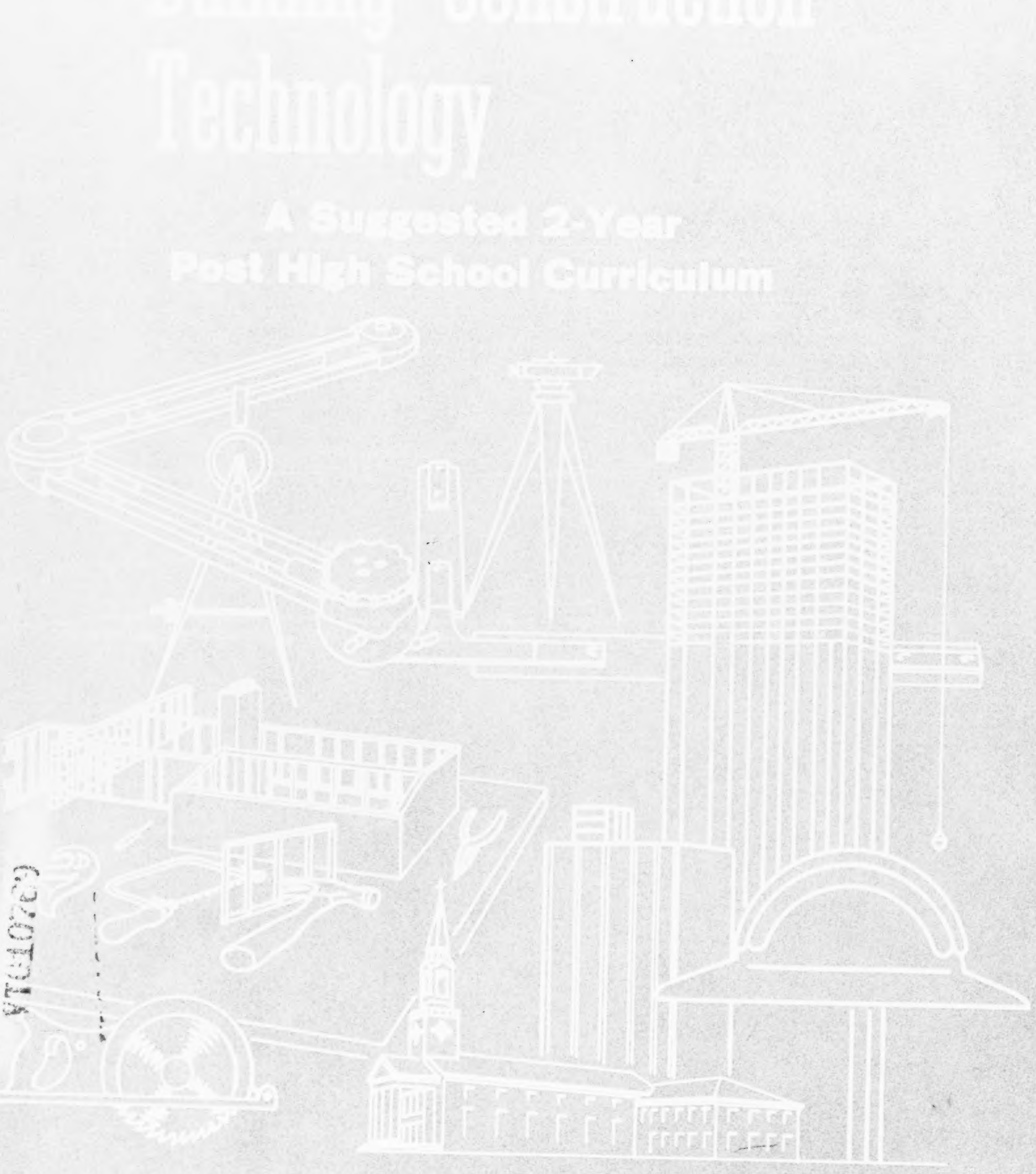
TECHNICAL EDUCATION PROGRAM SERIES NO. 9

Architectural and Building Construction Technology

A Suggested 2-Year Post High School Curriculum



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Technical Education Program Series No. 9

ARCHITECTURAL AND BUILDING CONSTRUCTION TECHNOLOGY

A Suggested 2-Year Post High School Curriculum

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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FOREWORD

ARCHITECTURAL DESIGNS using new materials and methods bring builder and architect together at the start, because planning the special construction procedures must begin as soon as form and materials are conceived and specified. These developments have created a serious shortage of highly skilled architectural and building construction technicians to assist architects and engineers in building construction. This suggested curriculum was prepared to aid in planning and developing programs in the States to meet the increasing need for such technicians.

The guide provides a suggested curriculum plan; course outlines with examples of texts and references; a sequence of technical education procedures; laboratory layouts with equipment and costs; a discussion of the library and its use, faculty and student services; and a selected list of scientific, trade, and technical societies concerned with the technology. Although the indicated level of instruction is post high school, the sequence of course work may well start at any grade level where students have the prerequisite background and understanding.

This guide was developed by Walter J. Brooking, technical education specialist in the Program Development Branch of the Division of Vocational and Technical Education, U.S. Office of Education. The basic materials were prepared by Southern Technical Institute, Marietta, Ga., pursuant to a contract with the Office of Education.

Many useful suggestions were received from special consultants, architects, employers, building construction engineers, and from administrators and teachers in schools of technology. Although all suggestions could not be incorporated, each was considered carefully in the light of the publication's intended use. In view of this, it should not be inferred that the curriculum is completely endorsed by any one institution, agency, or person. It is a plan for a program; a plan to be modified by administrators and their advisers to meet local, State, and regional needs.

GRANT VENN
Associate Commissioner for
Adult, Vocational, and
Library Programs

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Donald W. Brown, Director, The Technical Institute, Oklahoma State University, Stillwater, Okla. 74074

Edwin B. Cromwell, F.A.I.A., Ginocchio, Cromwell, Carter, and Neyland, Architects, 416 Center Street, Little Rock, Ark. 72201

Ray F. DeBruhl, P.E., Chairman, Engineering Technology Division, Richland Technical Education Center, 316 Beltline Boulevard, Columbia, S.C. 29205

Ben H. Evans, AIA, Director of Education and Research Programs, American Institute of Architects, 1735 New York Avenue NW., Washington, D.C. 20006

James L. Haecker, Architect, Associate Director of Education and Research, American Institute of Architects, 1735 New York Avenue NW., Washington, D.C. 20006

Robert Hays, Head, English Department, Southern Technical Institute, Marietta, Ga. 30060

Robert M. Nady, Associate Professor, Technical Institute, Iowa State University, Ames, Iowa 50010

David Savini, Campus Architect (AIA, CSI), Georgia Tech Planning Office, 4th Floor, Administration Building, Atlanta, Ga. 30332

Thomas F. Sturr, Architect, The Perkins and Will Partnership, Chicago Office, 309 W. Jackson Boulevard, Chicago, Ill. 60606

B. R. Tinsley, Jr., Director of Technical Education, Manatee Junior College, Bradenton, Fla. 33505

Paul W. Witherell, Dean of Instruction, Wentworth Institute, 550 Huntington Avenue, Boston, Mass. 02115

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American Iron and Steel Institute
633 Third Avenue
New York, N.Y. 10017

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Washington, D.C. 20006

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Bluefield, W. Va. 24701

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Main Street and Youngs Road
Buffalo, N.Y. 14221

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1015 North Sixth Street
Milwaukee, Wis. 52303

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Wahpeton, N. Dak. 58075

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Washington, D.C., Office
837 National Press Building
Washington, D.C. 20004

Southern Illinois University
Carbondale, Ill. 62901

State of Michigan
Ferris State College
Big Rapids, Mich. 49307

State University of New York
Agricultural and Technical College
Canton, N.Y. 14904

Texas A & M University
James Connally Technical Institute
Waco, Tex. 76703

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THE PROGRAM

A GROWING population and a complex technological civilization have sharply increased total housing needs. At the same time the scientific developments that make it possible to provide almost complete environmental control for structures housing all indoor activities have made many buildings obsolete. The vast building requirements have created a serious shortage of highly skilled technicians in architecture and building construction to assist the architects and engineers in meeting the Nation's needs for housing and other buildings.

Technological developments have caused great changes in concepts, materials equipment, and methods of producing modern buildings. Some of the most important changes come from using new and sophisticated machines and carefully controlled industrial mass-production methods of fabrication of parts of buildings in factories, and then erecting or assembling the building on the site with a minimum of human effort. These concepts and methods have brought the builder with his construction arts and technical skills into early and close contact with the architect. Planning of the special fabrication processes and construction procedures must begin soon after the form of a modern complex building and the materials to be used to build it are conceived and specified.

The construction industry—including domestic, industrial, and commercial—has become one of the leading industries of the United States. In 1966 more than 3.2 million workers, or approximately 4.5 percent of the total work force, were working in contract construction, However, employment alone does not show the significance of the architectural and building construction industry to the economy. The expenditures and income of the construction industry rank it as one of the Nation's most vital enterprises. In recent years there have been more than one million units of "housing starts" each year. New construction expenditures in the mid-1960's were approximately $70 billion a year.

Not only is construction itself a major factor in the economy, but its use of supplies and services results in the employment of hundreds of thousands of workers and in billions of dollars of expenditures.

The conditions discussed below have made the construction industry important and have created the shortage of well-trained architectural and building construction technicians.

1. *The population explosion.*—The U.S. population rose from 140.5 million in 1945 to 194.6 million in 1965—an increase of more than 38 percent in the 20 years following World War II. Many of the babies born just after World War II had reached maturity by the mid-1960's. They were forming new families and moving into their own homes or apartments. The population increase has called for new homes, stores, places to work, roads, bridges, and public buildings. The population will undoubtedly continue to rise. And an increasing population will continue to demand its third necessity of life.

2. *The availability of more money for mortgage lending.*—Savings and loan associations, commercial banks, insurance companies, mutual savings banks, individuals, and many other sources of capital have loaned money for financing construction and renovation. Through such programs as FHA and VA insurance, the Federal Government has helped to make money available for construction.

3. *Demolition or renovation of buildings.*—The demolition of existing buildings has made jobs for thousands of people. Since 1960 the Nation has been tearing down approximately half a million dwellings a year. Many cities and Federal agencies have started slum-clearance projects. They have torn down outdated houses and are replacing them with more modern buildings or apartment projects. Expressways have been built

Figure 1.—Modern equipment, materials, and methods enable architects and technicians to create buildings of unusual design and beauty.

through neighborhoods, forcing destruction of houses and construction of new houses or apartments elsewhere. Many homeowners have repaired or remodeled their own homes.

4. *Increased interest in travel and recreation.*—As the length of the U.S. workweek has decreased, people have had more time for travel and recreation. Increased leisure has created a need for motels, hotels, and downtown motor lodges, highways and bridges, restaurants, recreation centers, and camps.

5. *Formation of new companies, need for increased production, and development of new products.*—Dozens of new buildings have been erected on the outskirts of cities since World War II. New products and new companies have required new factory buildings and offices. Many companies discovered after World War II that their existing plants—like the machinery inside the plants—had become too obsolete for economical production. In addition, new companies were formed; and older companies established subsidiaries. These developments have been especially important in such industries as electronics, plastics, and manmade fibers.

6. *New building materials and techniques and stricter codes and zoning regulations.*—Many materials now used for decorative effect, convenience, or even for buildings were unknown 30 years ago. Products such as prestressed concrete, violet-ray filtering heat-reducing glass, and electrically operated doors have stimulated interest in architecture and construction.

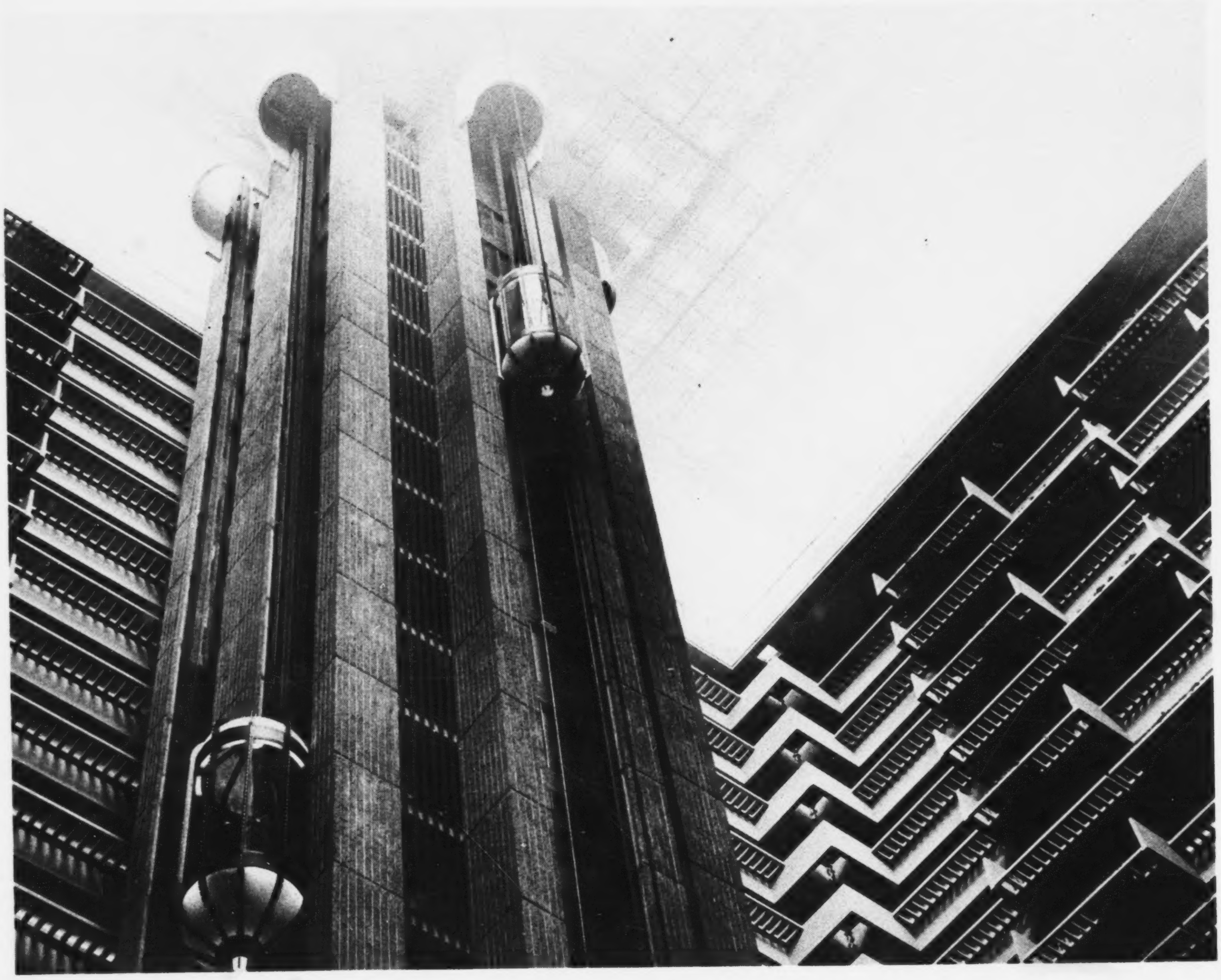

Figure 2.—This view of two of the five elevators which serve the lobby of a 30-story hotel building illustrates a type of structure on which architects, construction engineers, and technicians should work together from the beginning of the designing until it is completely built.

Many cities and counties have tightened their building codes and zoning regulations. More rigid codes have forced building owners to renovate.

The use of new materials and techniques and the requirements of codes have called for better trained persons. Contractors thus have greater need for mechanically competent employees to design, erect, or install new materials.

7. *The rising costs of construction.*—As other costs have risen, so have construction costs. Homeowners have been seeking more expensive homes. For example, in 1963 more homes costing under $15,000 were sold than those costing over $25,000. By 1966, the reverse was true.

As a home has become a more expensive investment and as construction costs have risen, contractors have sought better trained people. The well-trained technician in architecture or building construction can help cut costs and insure a better final product.

8. *Increased construction of public and semipublic buildings.*—Buildings for government bureaus, hospitals, churches, and other nonprofit groups have been erected. During the Korean War and the war in Vietnam, many military installations were renovated. New bases were built.

The construction of colleges and schools has been especially important. Federal legislation has provided significant financial stimulation to improve existing school facilities and to erect new buildings. State and local governments have matched Federal funds on many projects and built many schools without Federal aid. Many

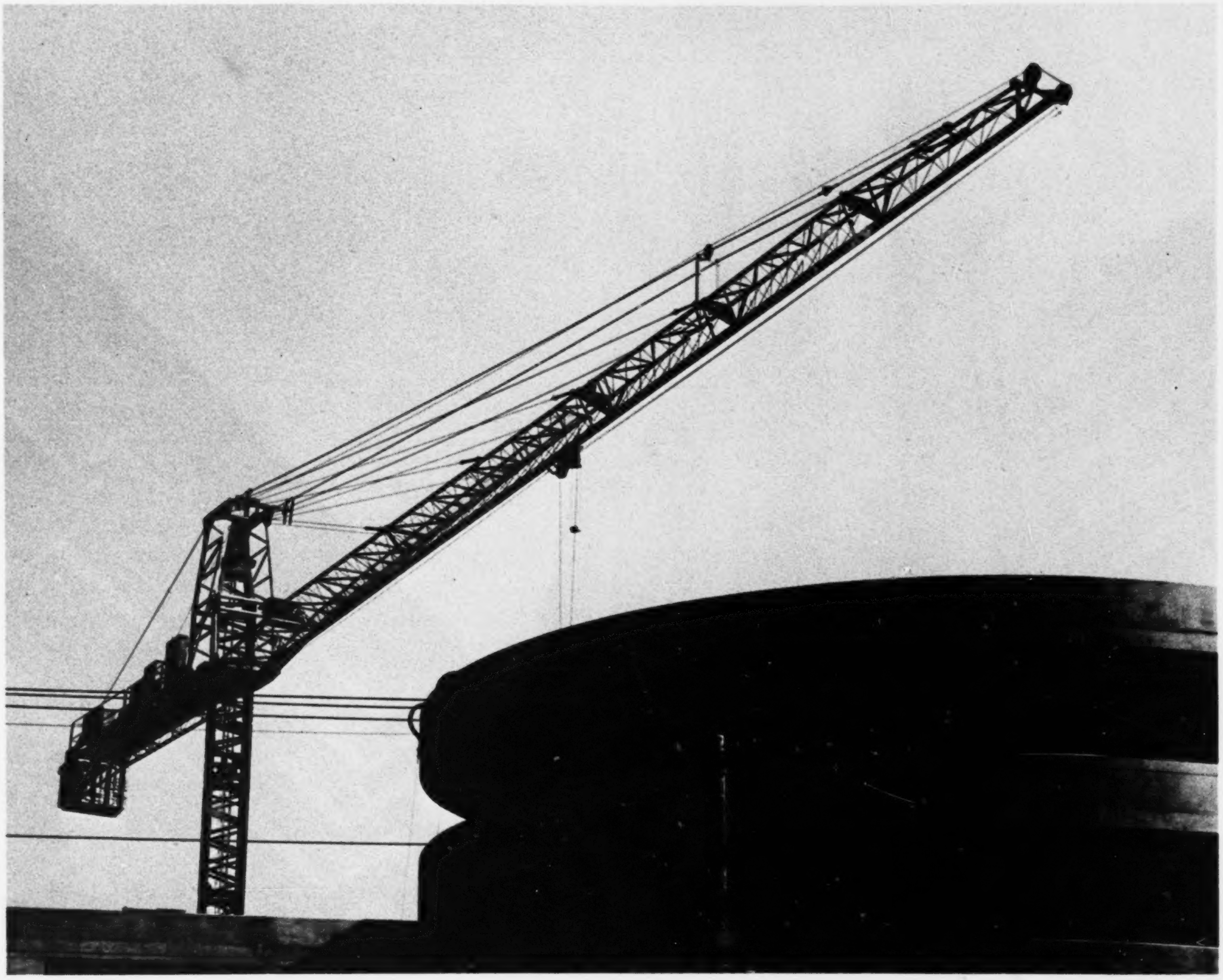

Figure 3.—New kinds of construction machinery such as this gantry crane and novel and efficient uses of materials permit freedom of architectural design until recently unknown in building construction.

private schools and health facilities have been built.

Population growth has led to a continuing demand for new classrooms or new schools, and parents are demanding better facilities for existing schools.

9. *Demand for better housing and better cities.*—The United States is becoming an urban Nation, with the majority of the population now living in or near cities. Some cities must be rebuilt to eliminate slums; others are expanding both vertically and horizontally. Some entirely new cities with industrial and scientific research areas are arising from swamps and farmland. People are demanding ever-improving places to live, to shop, to work, and to find recreation.

In summary, the construction industry is vital and growing. Well-prepared construction technicians are in short supply, and there is a continuing need to develop programs to educate others.

General Considerations

The objective of the total program recommended in this guide is to produce a competent architectural and building construction technician. The technician must be capable of working and communicating directly with architects, engineers, scientists, contractors, and operating employees in his specialized work; of satisfactorily performing work for his employer; and of growing into positions of increasing responsibility. In addition, the graduate technician should have a beginning basis for becoming an active, well-informed member of society.

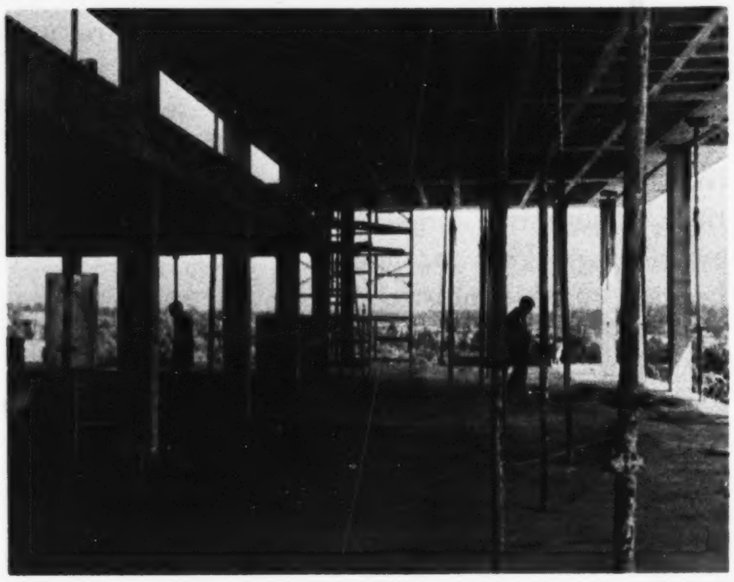

Figure 4.—Architectural and building construction technicians must be knowledgeable about the modern standardized forming and supporting procedures and devices used for economical construction of reinforced concrete buildings such as this one.

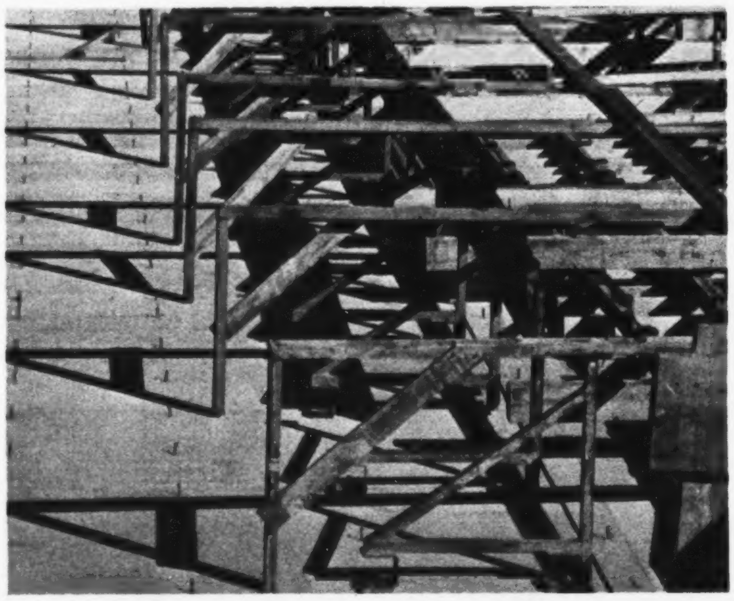

Figure 5.—Prefabricated forming elements, often using standardized patented devices, greatly reduce the human effort in repetitive operations in building modern concrete structures. Technicians usually do the routine designing, supervise the fabrication of the forming elements, assist in planning the sequences of using them, and control the quality of the construction on which they are used.

A program, which, when mastered, will produce the type of graduate described above, must be carefully designed. Each course must be planned to help the student develop knowledge and skill in its particular area and be directly integrated into the program. The sequence of courses, each of which is specially constructed, contributes toward the final objective of producing a competent technician. If close correlation of courses making up the program is not maintained, the

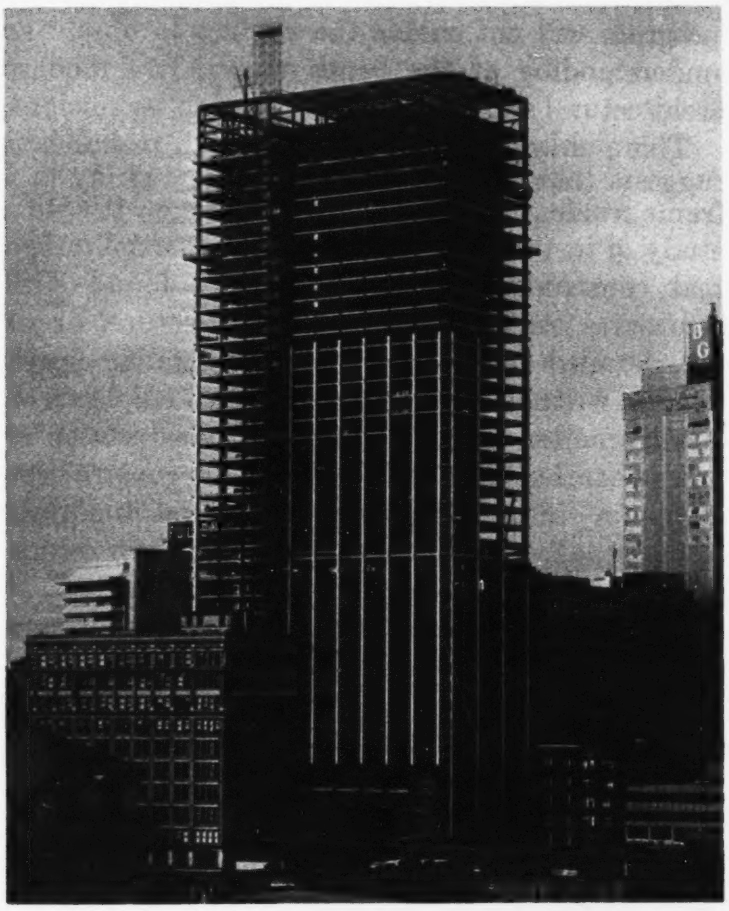

Figure 6.—Most of the elements of the structural steel frame for this building were prefabricated in factories, shipped to the building site, and erected. This includes curtain wall elements as well as steel framing. Technicians must understand the critical path method of planning and controlling such modern construction.

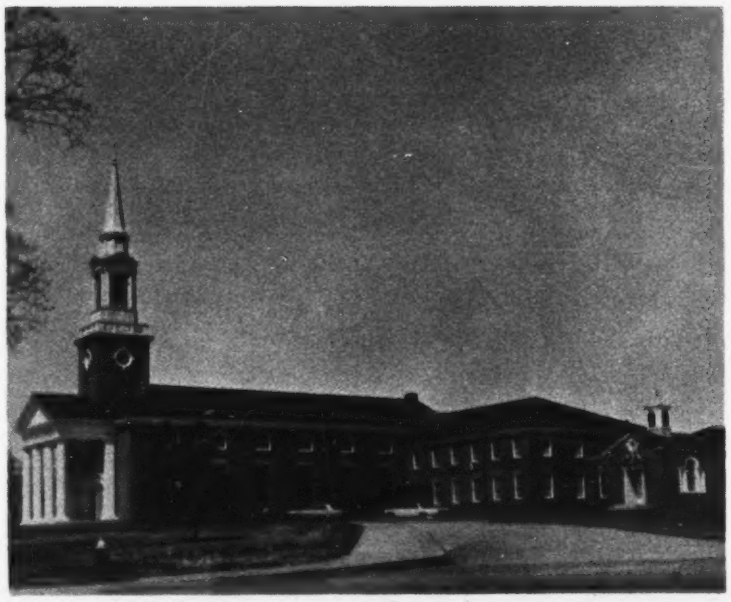

Figure 7.—Unfilled demands for a wide variety of new buildings to house a growing population and to replace large numbers of obsolete buildings create a serious, unfilled requirement for technicians.

program will not enable the student to obtain an understanding at the depth required of modern architectural and building construction technicians.

This publication for educating such technicians suggests that the student begin with a study of a frame residential construction, and follow it with a study of institutional and large commercial design and construction. Instructors have found such structures useful for teaching architectural drawing, detailed design, construction, planning, specification writing, and job planning. An emphasis on either smaller, frame or masonry construction or on noncombustible and fire-resistant construction of major institutional and industrial buildings could equally well be used. It is therefore recommended that each institution, with its analysis of building requirements and the recommendations of its advisory committee, decide whether to follow the combined approach used here or to emphasize either smaller residential and commercial construction or larger institutional and industrial construction. With either emphasis, it is suggested that the student begin with a study of light construction.

The technical content of the program is intended to supply a wide background in the diverse areas of applied architecture and construction. In the first year the student should acquire a firm foundation in architectural drawing, building materials, and building methods and equipment, along with training in mathematics, physics, and communication skills. In the second year he builds directly on this background but takes up more advanced material from architecture and construction such as surveying, technical reporting, building service systems, architectural mechanics, history of architecture and construction, contracts, codes, specifications, and office practices, industrial organization, economics, and estimating. The methods of analysis steadily become more sophisticated as the student progresses through the program.

Graduates of this program can expect to find employment in many areas of the architectural and building construction fields. Each area may require somewhat different abilities and specialized knowledge and skills for a successful career. Most graduates will further develop their abilities by continued study on the job or in part-time study to master the specifics of a special field. The following listing shows examples of only a few of the major areas or clusters of job opportunities for architectural or building construction technicians, as described by employers. Some are beginning jobs; others are attained by experience and study on the job.

1. Estimator—A technician working for a contractor in estimating for bids or doing materials take-off ("quantity surveying") from architectural plans.
2. Draftsman—A technician working in an architectural office or for a construction company in preparing completed drawings from preliminary sketches.
3. Chief draftsman—An experienced technician responsible not only for some of his

Figure 8.—Wood frame building and construction such as that shown here still represents a large and important part of the Nation's building. Technicians must understand this kind of construction.

Figure 9.—Technicians must understand drawings, bills of materials made from them, and the need for care and precision in their preparation. Most architectural and building construction jobs require technicians to have some skill in drawing.

employer's most important drafting but also for supervising the work of other draftsmen.

4. Construction foreman—A technician who has developed his leadership talents and uses them in supervising construction crews. Depending on his background and experience, he may supervise earth-moving, site-locating, concrete-pouring, or other work in erecting a building.
5. Field engineering assistant—A specialist who may represent a contractor, a client, or an architect. His duties may be partly supervisory and partly technical. He checks construction work at various stages against drawings and specifications.
6. Maintenance foreman—A technician who supervises maintenance crews as a part of plant engineering or building engineering. His responsibilities may include electrical wiring and lighting, elevators, mechanical (plumbing, heating, and air conditioning) systems, roads and grounds, or a combination of these.
7. Surveyor—A "field" technician. This person may or may not be a licensed surveyor. He may survey and stake out locations, concrete framing, and batter boards. If he is a licensed surveyor, he must meet his State's requirements for the license.
8. Contractor—A self-employed businessman. Many architectural and construction technicians have gained experience by working for larger construction companies. Then, after accumulating some capital, they have started their own construction companies.
9. Building supplies salesman—An "inside" man. This technician is employed by large lumber and materials companies. He works primarily with contractors in helping them prepare, verify, and acquire the items on materials lists, and in pricing and overall cost estimating.
10. Building inspector—A construction specialist familiar with all types of construction and the local and national codes governing them. An inspector may work for an insurance company or an architect or he may serve as a government inspector who checks compliance with building codes. A building inspector may be concerned with specialized aspects of construction such as public safety; fire and health hazards; plumbing and electrical systems; and Federal regulations.

Besides technical skill, some of the preceding jobs call for particular personal traits. For example, ability and training in salesmanship are important in working for a building supply house. Highly skilled technicians must be capable of working closely with engineers, architects, and other technicians and of supervising and coordinating the efforts of skilled workmen.

Technician education programs develop highly specialized persons who must be able to perform many tasks requiring special skillls and who must approximate the professional in education, attitude, and competence. Such programs provide for rigorous study of scientific principles and supporting mathematics and for intensive laboratory and field practice oriented to instruction. Such programs must provide students opportunities to gain (1) knowledge of applied scientific principles and of the hardware, processes, procedures, techniques, materials, and tools and (2) the ability to communicate with the professional architects and engineers or contractor employees, and to serve as delegates or assistants to such persons. Such programs are generally designed for 2 years of intensive post high school study, but many technical and some comprehensive high schools provide for technical and related vocational education.

Some indication of the special nature of technicians programs, whether in architectural and engineering fields, in specialized construction occupations, or in the management of construction may be obtained from an analysis of what technicians must know, what special abilities they must possess, and what they must be able to do in their daily work.

Special Abilities Required of Technicians [1]

Technicians must have the following special abilities:

1. Proficiency in the use of the disciplined and objective scientific method in practical application of the basic principles and laws of physics and chemistry and/or the biological sciences as they constitute the scientific base for the individual's field of technology.

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[1] Adapted from *Occupational Criteria and Preparatory Curriculum Patterns in Technical Education Programs* (OE-80015), U.S. Office of Education, Washington, D.C. 20202.

2. Facility with mathematics: ability to use algebra and trigonometry as tools to develop, to define, or to quantify scientific phenomena or principles; and, when needed, an understanding of, though not necessarily facility with, higher mathematics through analytical geometry, calculus, and differential equations, according to the requirements of the technology.
3. A thorough understanding of and facility in the use of the materials, processes, apparatus, procedures, equipment, methods, and techniques commonly used in the technology.
4. An extensive knowledge of a field of specialization with an understanding of the application of the underlying physical or biological sciences as they relate to engineering, architectural and building construction, or research activities that distinguish the technology of the field. The degree of competency and the depth of understanding should be sufficient to enable the technician to establish effective rapport with the architects, engineers, or management persons with whom he works; and to enable him to perform a variety of detailed scientific or technical work as outlined by general procedures or instructions but requiring individual judgment, initiative, and resourcefulness in the use of techniques, handbook information, and recorded scientific data.
5. Communication skills that include the ability to record, analyze, interpret, and transmit facts and ideas with complete objectivity orally, graphically, and in writing.

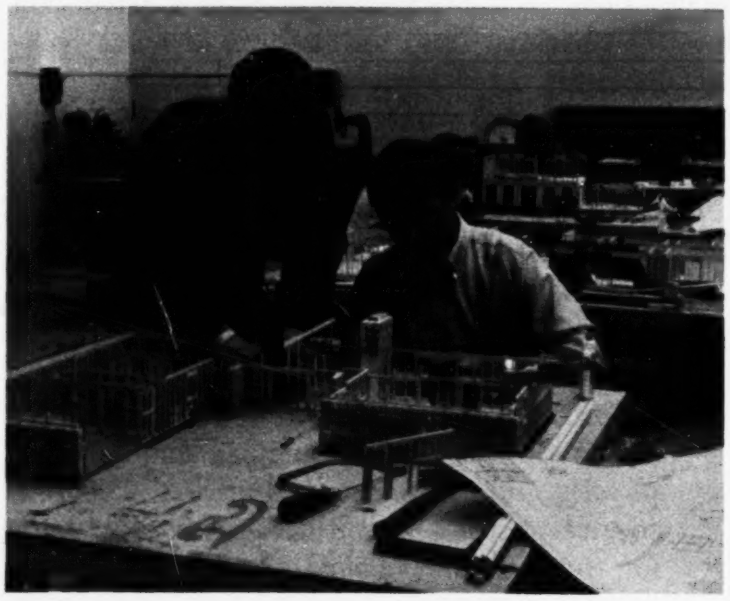

Figure 10.—Technicians employed by architectural firms are often required to make models such as this. A model-making laboratory is an important part of a building and construction technology program.

Activities Performed by Technicians[2]

A technician must perform a variety of functions. He must be prepared to—

1. Apply knowledge of science and mathematics extensively in rendering direct technical assistance to architects, engineers, or construction contractors, superintendents, and foremen engaged in construction work.
2. Design, develop, or plan modifications of new products, procedures, techniques, processes, or applications under the supervision of architectural, engineering or construction contractors, superintendents, or foremen in applied construction work.
3. Help plan, supervise, or inspect construction of residential, industrial, or commercial structures.
4. Help plan construction; work as a member of the management unit responsible for efficient use of manpower, materials, money, and equipment in construction work technical service.
5. Advise, plan, and estimate costs of operations as a field representative of an architect, an engineer, or a contractor.
6. Assume responsibility for supervision or inspection of construction projects; prepare technical reports covering supervision or inspection.
7. Prepare or interpret engineering drawings and sketches or write detailed specifications or procedures for work related to construction.
8. Select, compile, and use technical information from references such as engineering standards; handbooks; specifications; and technical digests of publications about construction.
9. Analyze and interpret information obtained from site inspections, and make evaluations upon which technical decisions are based.
10. Analyze and diagnose technical problems that involve independent decisions. Judgment must be based not only on technical know-how on but on substantive experience in the occupational field as well.
11. Deal with a variety of technical problems which must be solved by a person with

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[2] Ibid.

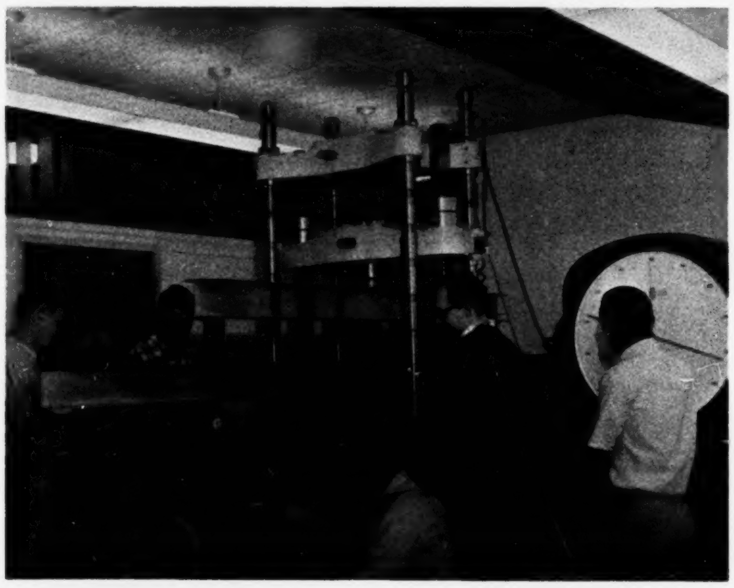

Figure 11.—Technicians must know how to use the precision equipment in testing the materials and elements of buildings and how to interpret the results of the tests. This kind of laboratory equipment is essential to a program educating technicians.

an understanding of several technical fields. Such versatility depends on broad experience in applying scientific and technical principles, the antithesis of narrow specialization.

A 2-year program to educate architectural and building construction technicians must concentrate on primary or fundamental needs if it is to prepare students for responsible technical positions in the modern industry. It must be realistic and pragmatic. *The program suggested in this bulletin has been designed to provide maximum technical instruction in the time that is scheduled.*

To those who are not familiar with this type of educational service (or with the goals and interests of students who elect it), the technical program often appears to be inordinately rigid and restrictive. While modifications may be necessary in certain individual institutions, the basic structure and content of this program should be maintained.

The specialized technical courses in the program are laboratory- and field-oriented. They provide time for the application of the scientific principles concurrently being taught in the courses in physics, mathematics, and architectural drawing. *For this reason, mathematics and science courses must be coordinated carefully with technical courses at all stages of the program.* This coordination is accomplished by scheduling mathematics, science, and technical courses concurrently during the first two terms, a principle that will be illustrated at several points. General education courses constitute a small part of the total program. It has been found that students who enter a technical program do so because of the depth of specialization that the program provides. Experience shows that many students who elect this type of program bring to it a background of general study.

Faculty

The effectiveness of the program depends largely upon the competence and the enthusiasm of the teaching staff. The specialized nature of the program requires that the teachers of construction subjects have special competence based on proficiency in technical subject matter and construction or architectural experience. It is important also that all members of the faculty understand the educational philosophy, goals, and unique requirements that characterize this program.

To be more effective, members of the faculty responsible for this program must have interests and capabilities which transcend their areas of specialization. All of the faculty members should be reasonably well informed of the requirements for study in architectural and construction practices so that they may use field examples or subject matter as supporting material in teaching. For example, if the construction courses are to be of maximum value, the teacher must be familiar with the construction problems and demands placed on technicians. Without such a background, the teacher cannot give course work the support that is needed in the total program of education for the technicians. Similarly, various scientific principles may be taught in courses in physics and mathematics, and the course instructors may emphasize the principles and illustrate them in design and application.

Teachers of specialized technical subjects require advanced technical training. In the past many teachers have been recruited from the architectural and engineering professions. Recent experience has shown that architectural or engineering technology graduates who have acquired suitable architectural and/or construction experience and who have continued their technical and professional education often become excellent teachers in this type of program. Such persons are more likely to understand the objectives and unusual instructional requirements of technical education. Furthermore, persons with this particular background often bring to the program an enthusiasm for and an appreciation of the values of technical education—characteristics that are essential to the success of any educational program.

Since programs for highly skilled architectural and building construction technicians must be a series of well-integrated courses if the scope and depth of training given are to be adequate, careful consideration must be given to when and at what level a new concept is to be introduced. This may be accomplished through "team-teaching." In this sense, team-teaching is the organization of a technical staff into a coordinated teaching unit. Teaching assignments are made on the basis of the individual member's special training and talents. Concurrent courses are closely coordinated by team members to best utilize the student's time while he is moved smoothly on to progressively higher levels of understanding.

"Team-teaching" can be developed and nourished only by the teaching faculty. A weekly departmental staff meeting to encourage the development of "team-teaching" is recommended. At these meetings, each instructor should check with instructors of concurrent courses to insure that courses are being coordinated. This is especially important when new courses or new techniques are involved. If less optimum coordination is evident, the team can analyze the problem and quickly find a solution.

In addition to keeping concurrent courses well coordinated, staff meetings provide for free exchange of ideas on teaching techniques discovered to be useful, and on recently developed laboratory projects which seem to be particularly successful. Any project which seems especially interesting and beneficial to the student should be analyzed to see whether the same principles of presentation can be employed in other projects. Furthermore the meetings provide for discussion of scientific or technical journal articles which may improve the teaching of a subject or which present new information which should be taught.

No matter how well trained a faculty member is, he should never feel that he has completely mastered architecture and building construction. Throughout his professional career he must be on the alert for new techniques, materials, and equipment. He must continue to read, to study, to maintain contact with the construction industry, and to visit architectural and construction offices. In brief, he must not attempt to teach tomorrow's practices to today's students if he has only yesterday's knowledge.

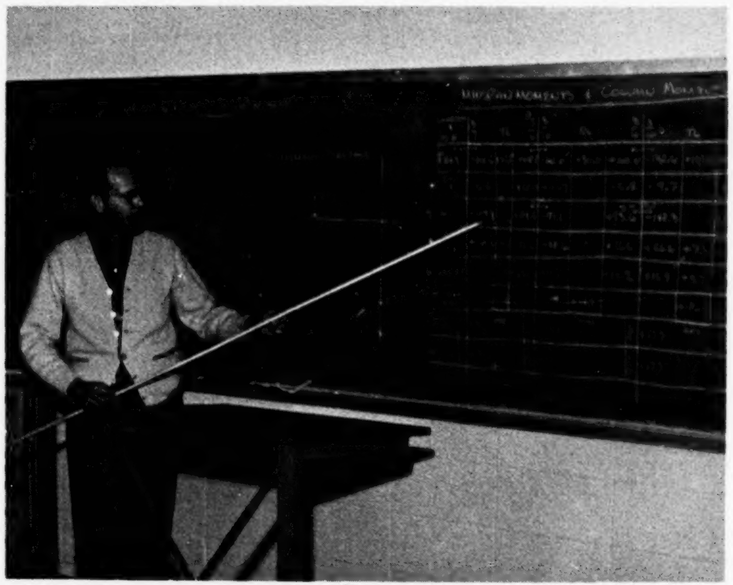

Figure 12.—Teachers of the technical specialty courses in this technology must have had up-to-date experience in the field in order to teach modern design and construction methods.

The institution must try to bring the most competent instructors into the classrooms. It should attempt to employ instructors with both technical qualifications—such as licensed architects and professional building construction engineers—and proved teaching ability. It may well consider seeking instructors "on loan" from architectural and contracting firms or employing specially qualified instructors part time or as guest lecturers. It must always encourage its full-time faculty members to upgrade their professional qualifications.

To help keep a staff effective, an institution should encourage faculty members to participate as active members of professional and technical societies. Through such organizations they can keep up with new literature in the field and maintain closer liaison with employers of technicians or other leaders in the field. By attending meetings they can hear addresses by outstanding specialists in the field. Technical school administrators are increasingly encouraging the self-development of staff members by providing released time and financial assistance to those who attend society meetings and technical teacher-training institutes. Periodic or sabbatical leaves should be offered to allow staff members a chance to increase and update their industrial experience, or for further study.

When determining teaching loads for teachers of technical specialty courses, administrators should consider the number of student contact hours required by their schedules. Fully effective instructors in this field require considerably more time to develop courses and laboratory materials than do shop instructors teaching vocational skills, or teachers of general education courses. A contact-hour workload of from 15 to 20 hours a week usually constitutes a full teaching load for technical specialty teachers. The rest of their time should be spent in assisting students and in developing courses and effective laboratory experiments.

Class size must be considered in developing effective teaching, since individual attention is recognized as a vital element in teaching. The maximum size of a lecture class may vary somewhat, depending on the material to be covered, the lecture room, and the teaching techniques used; but for blackboard lecturing, class sizes of from 20 to 30 students usually should be considered optimum. If little or no class discussion is attendant to the lecture and if the parts of the lecture normally written on the blackboard are carefully prepared and presented by an overhead projector, the size of the class may be significantly increased.

Careful planning of laboratory teaching is important. Laboratory sections should not be overloaded with students. Teaching cannot be effective if there are too many students per workgroup or if too many different experiments are being conducted simultaneously in the same laboratory. If too many students try to work on a project, most of them will not benefit from the experiment, because they cannot participate sufficiently in *doing the work*. An optimum group size is usually two students per laboratory setup, although some experiments can be effective for groups of three or even four. If too many experiments are underway, the laboratory instructor cannot be effective, and the laboratory experiments cannot be closely coordinated with theory lectures.

Technical programs are designed to produce supporting employees who increase the effectiveness of engineering teams. The same principle of assistance may be employed to increase the effectiveness of the teaching staff. Staff assistants may be used in stock control to set out the proper equipment for laboratory classes, to keep equipment operating properly, to fabricate training aids, and to do a limited amount of routine paper-grading. When assistants do these important but time-consuming jobs, the teaching staff can devote more time to developing courses, preparing handouts to supplement lecture material, and insuring that necessary components and properly functioning equipment will be available when needed. Resourceful use of supporting personnel makes it possible to have a small but versatile staff which may be maintained as enrollment varies. By adjusting the size of the supporting staff to the demands of enrollment, a school may at least partly solve the problem of having too few instructors when the enrollment is high and too many instructors if enrollment is reduced. Most of the supporting staff members may be recruited from the student body or graduates from the program.

Student Selection and Services

Since the ultimate objective of the program is to produce high-quality graduates, it is essential that the students accepted into the program have certain capabilities. If the incoming student's background is inadequate, the instructors will tend to compromise the course work to allow for the inadequacies, with the probable result that the program will be inadequate in depth and scope.

Students chosen for this program should have similar backgrounds and capabilities and should exhibit some evidence of maturity and seriousness of purpose; otherwise the program might not achieve its objectives. Wide ranges of ability among students can create an inefficient teaching situation and thereby prevent the program from progressing at the necessary rate. The amount of material to be presented and the principles to be mastered require students who not only are well prepared in formal course material but also have the ambition, desire, and will to master a difficult program and to develop their capabilities to the limit.

The program is designed for high school graduates who have particular abilities and interests. In general, students entering the program should have completed a minimum of 2 years of high school mathematics, including algebra and geometry, and 1 year of physics, and laboratory experience, or the equivalent. Knowledge of chemistry is desirable, but physics is considered necessary.

The ability levels of those who do, and those who do not, meet these general requirements will vary greatly. If a student enters a program without adequate preparation, he will usually fail; if a class, or majority of a class, begins without the requisite preparation, the program cannot prepare highly capable technicians, and to that extent the program will fail. If applicants for admission do not have the necessary mathematics, science, or language skills, they should take remedial work before entering the technical program. If possible, this remedial work should be offered at the school where the applicant plans to enter a technical program.

Many institutions which offer programs for technicians provide pretechnical programs up to a full year's duration to give promising but underprepared students the opportunity to enter a technical program of their choice with a good probability of successfully completing it. A pretechnical program helps solve student recruitment problems, provides assurance of high quality of graduates by starting with adequately prepared students, and gives promising students an opportunity to educate themselves to meet the Nation's urgent need for technicians.[3]

Effective guidance and counseling are essential. The student should be aided in selecting educational and occupational objectives consistent with his interests and aptitudes. Whenever possible, institutions offering technical programs should consider the use of standardized or special tests to assist in student selection, placement, and guidance. A student should be advised to revise his educational objectives if it becomes apparent that he lacks interest in the technical program or lacks ability to complete the program satisfactorily.

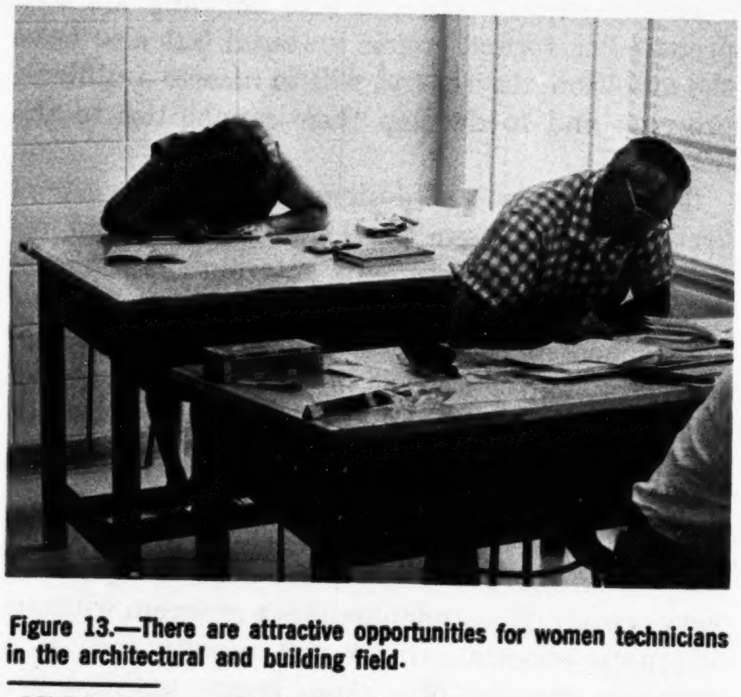

Figure 13.—There are attractive opportunities for women technicians in the architectural and building field.

The new student should quickly become familiar with the facilities on campus. In particular he should be given a tour of the library facilities and be made familiar with the procedures and rules governing the use of the library. If possible, organized fieldtrips to nearby construction jobs should be arranged early in the program to give new students an opportunity to see architectural and building construction technicians on the job. These tours may provide motivation and perhaps point out why certain required subjects are important.

A departmental student organization may be formed to help bring together people with similar interests. The meetings of this organization should provide exercise for the students in arranging their own technical programs. Speakers from architecture or the construction industry or selected films may be used to stimulate interest at meetings. Student organizations may assist with and participate in department activities such as "career days" and "open house" events.

Students should be given information concerning student membership in technical societies and be encouraged to join such societies. Student chapters of professional societies offer an opportunity for the student to receive excellent material on a regular basis at nominal costs, and to associate with professional people in his field at meetings. After graduation, the technician may find affiliation with a society and regular reading of journal articles an important method of keeping his technical knowledge current in the field.

As their graduation approaches, students should be made aware that some tasks open to technicians may be licensed or certified and that certification may be important for their future employment. To the extent permitted under State licensing requirements, students should be encouraged to get certification or other licenses as quickly as possible.

The academic achievement of students should be recognized in some manner. Many institutions grant graduates an associate degree as tangible recognition of achievement. A departmental club might present an annual award to an outstanding graduate. Private companies might offer to contribute to an annual scholarship award.

Graduates of technical programs should be aided in every way possible in finding suitable employment. Placement officers should be aware of the needs of the construction industry for technicians and should acquaint prospective employers with the qualifications of graduates. The placement function is an extremely valuable service to the student, the institution, and the employers. In the final analysis, the placement of graduates is an important responsibility, which is directly or indirectly the concern of the department head or the instructor who teaches the technical specialty. An excellent placement record is important in getting new students. In addition, the school should conduct periodic followup studies of its graduates to determine their progress and to evaluate their training. Many times such studies can indicate how the program or teaching techniques can be improved.

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[3] U.S. Department of Health, Education, and Welfare, Office of Education. *Pretechnical Post High School Programs, A Suggested Guide.* OE-80049. Washington: Superintendent of Documents, U.S. Government Printing Office, 1967.

Textbooks, References, and Visual Aids

Textbooks, references, and visual aids for teaching any technology must be reviewed constantly and supplemented in the light of (1) the rapid developments of new knowledge in the field, and (2) the results of research in methods of teaching and developing basic concepts in the physical sciences and mathematics. This is especially true in the field of architecture and construction. The development of whole new areas of theoretical and applied scientific knowledge is demanding new textbooks, new references, articles in scientific and technical journals, and new visual aids materials.

New textbooks will reflect recent methods of teaching scientific principles and applications as fast as current research in education becomes applicable. Recent extensive research in methods of teaching mathematics and physics certainly will produce changes in teaching materials and methods. It is therefore mandatory that instructors constantly review modern texts, references, and visual aid materials as they become available and *adopt* those that are an improvement over the ones suggested here or those currently in use.

The suggested texts and references have been carefully selected; however, more good texts at the technician level are needed in architectural and construction education. From the lists presented, it should be possible to select suitable ones. There are, no doubt, other books which are excellent.

Before a department head or instructor undertakes a program in architectural and building construction technology or any course contained in the program, he should familiarize himself with the texts and references listed here and others which are available. He will then be able to select the text which best serves his particular needs in making a lucid, high-level technical presentation to his students.

Visual aids can be of great help in teaching programs. The aids which are noted here have been selected from an extensive list and represent those considered most suitable at the time the curriculum was prepared. Many are not listed, because the variety and extent of the materials make an all-inclusive listing prohibitive. From those listed and others available and pertinent, an instructor may select visual aids which meet his teaching objectives. He should *always* preview and study visual aids before using them in teaching.

Laboratory Equipment and Facilities

Laboratories and equipment for teaching architectural and building construction technology programs must meet high standards of quality, since the objectives and the strength of the programs lie in students getting valid practical experience, basic in nature and broad in variety. Well-equipped laboratories with sufficient facilities to enable all students to work in the laboratory are required for the courses. The student's training program should include experiences which illustrate the function and application of a wide variety of standard tests and functional systems and their representative uses.

Variety and quality of equipment and facilities are more important than quantity in equipment laboratories. Laboratory equipment and facilities are a major element of the cost of such a program, but they are indispensable if the training objectives are to be met.

Equipment must be of good quality if laboratory work is to offer the student valid experiences. Inferior equipment may not show the principles being studied or may not be sensitive enough to provide reliable or precise data. Such equipment may require unreasonable amounts of time and expense for repairs or adjustment. The initial cost of high quality equipment is usually greater than that of low quality, but the difference in cost is justified because it makes possible laboratory experiments that give precise results.

In the selection of laboratory equipment, the need for each item should be well established.

Expensive apparatus may not always be required. Many significant experiments can be made with relatively inexpensive components. In fact, in many cases these components can make it easier for the student to understand the principles because they present only the essentials. The number of units purchased, the particular areas of interest, the particular industry emphasis, and the ingenuity of the instructors in adapting equipment to teaching needs will in part govern the selection and cost of laboratory equipment. Throughout the program, the emphasis should be on the principles which serve as the basis for solving so many different construction problems.

A recommended approach to developing laboratory work and equipping the laboratories is to determine what experiments and experiences are needed for each course and then to design the exercises, so far as possible, using standard components and equipment which are representative of those currently being used in the industry or in related government agencies. This approach requires staff time and effort; but because the experimental equipment has been assembled to demonstrate some principle or to make a specific experimental determination with clarity and precision, it usually accomplishes the best teaching. Laboratory equipment and facilities are discussed in more detail in a later section, entitled "Facilities, Equipment, and Costs."

The Library

In any evaluation of a technology program, its strength is indicated by the quality of its library. It is indicated by the qualifications of the librarian; the facilities, the quality, quantity, and relevancy of content; and the staffing and organization of the library.

Dynamic developments causing rapid changes in technological science and practice make it imperative that the student learn to use a library. Instruction for technology students should therefore be library oriented so that they may learn the importance of being able to find information on any of the various courses they are studying. They should form the habit of using the library as a tool in learning. This knowledge helps students develop a professional attitude and further teaches them to depend on libraries to keep abreast of new developments.

Instructors of all courses should inform their students that library use is an important part of the program. Planned assignments that require the use of the library to prepare reports on pertinent subjects will enable students to understand the resources available and their relation to technology. Open-book examinations that require the use of the library provide excellent and objective experiences. Under the incentive of the examination and the pressure of time, students obtain a clear understanding of their own competency in using the library.

The growth and success of the graduate technician will depend largely on his ability to keep up with changes in his field.

For this reason a central library under the direction of a professional librarian is important to the success of the technology program. Most instructors have private libraries in their offices from which they may select books of special interest to discuss in their personal conferences with students and thereby stimulate their interest in related literature. However, a central library insures the acquisition and cataloging of the library content according to accepted library practices and provides systematic card files, which facilitate the location of reference materials. It also provides a controlled and orderly system for lending books to students typical of those in libraries which they might use as employed technicians. Provisions for lending materials for out-of-library use should be systematic and efficient. Suitable study space should be provided students for use of references.

The head librarian usually reports to the top administrative officer of the school and has full faculty status. The American Library Association (ALA) standards state: ". . . two professional librarians are the minimum number required for effective service in any junior college with an enrollment up to 500 students (full-time equivalent). In addition, there should be at least one nonprofessional staff member. The larger the institution, the more appropriate it will be to employ a higher proportion of nonprofessional staff members."

According to ALA, the library budget should be determined in relation to the total budget of the institution for educational and general purposes, but the amount to be allocated to the library should be based upon a program of optimum library service in support of the school's goals. The execution of the library program, as it is outlined in the ALA standards, normally requires a minimum of 5 percent of the total educational and general budget. This minimum percentage is for a well-established library with an adequate collection. It would have to be increased if there were a rapid increase in the student body or in course offerings; it would again need to be increased if the library were made responsible for an audiovisual program. The library budget for a newly organized institution should be considerably higher than 5 percent.

Another ALA criterion for the library budget is that the funds for acquiring new library materials should equal or exceed the total of salaries for the library staff. This is for established libraries; the expenditure for acquisition of new library materials should be substantially greater for libraries which are just starting or making major additions to programs.

A library must provide adequate literature containing the information encompassed by all subjects in a program and extending somewhat beyond the degree of complexity or depth of that students cover in classrooms. Literature dealing with unusually highly specialized aspects of a subject may be acquired as needed or may be borrowed by the librarian from more comprehensive libraries.

The library content should meet the needs both of full-time students and of the part-time students' supplemental courses to upgrade or update their occupational knowledge and skills. In addition, it should serve the day-to-day needs of the instructors as they keep their own technical knowledge abreast of the new developments pertinent to their special field of applied science.

In view of the highly specialized nature of library content for architectural and building construction technology, the department head or chief instructor of the technology should be a member of the library committee and should be responsible for approving the reference material selected for the technology and related courses. The librarian, as chairman of such a committee, may be expected to take the initiative in calling meetings or informally consulting with the head of the architecture and building construction technology department so that within the limitations of the budget and the consideration of total library needs, the department will acquire the appropriate library content.

The teaching staff and the library staff should cooperate in determining what materials are to be acquired and should be responsible for the final selection of the materials that support their technical courses. They must take the initiative in recommending materials to keep the library current, pertinent, and useful. The library staff should supply the teaching staff with a periodic list of recent acquisitions complete with call numbers. Technical and trade journals should either be circulated among the teaching staff or be placed in a staff reserve section for a short time before they are made available for general library use.

In addition to reference materials, journals, and trade publications, a library should have encyclopedias available for quick reference and should maintain index material such as the *Engineering Index* and the *Applied Science and Technology Index* to aid staff and students in finding recent material on specific subjects. If visual aid materials are centered in the library, they should be reviewed and evaluated by both the librarian and a member of the teaching staff as they become available. This procedure will inform the teaching staff on what visual aids are available and where they may be used best in the technical programs.

A well-equipped, modern library should have some type of duplicating service available so that copies of library materials may be easily obtained by students and staff. Such a service allows both students and staff to build up-to-date files of current articles appropriate to the courses in a program. The service should be available to the students at a minimum cost and free of personal cost to the teaching staff.

Further suggestions and discussion of library content for the technology are provided in appendix B.

Scientific and Technical Societies

Scientific and technical societies[4] and trade associations are an important source of instructional materials and other benefits for faculty members and students. Such societies provide, through their publications and meetings, immediate reports and continuing discussion of new concepts, processes, techniques, and equipment in the physical sciences and related technologies. The presentation and interpretation of scientific and technical discoveries explain the relationship of the theoretical scientist's work to the applied science practitioner's requirements. They are an invaluable aid in keeping abreast of new developments in a particular phase of science.

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[4] U.S. Department of Health, Education, and Welfare, Office of Education. *Scientific and Technical Societies Pertinent to the Education of Technicians.* OE-80037. Washington: Superintendent of Documents, U.S. Government Printing Office, 1966.

Less conspicuous, but extremely important, is the support which societies may give (1) in helping to develop evidence of need for a training program, (2) in helping to promote the program, (3) in enlisting members' support for the program, (4) in helping to provide work experience for students, and (5) in helping with the placement of graduates.

Associations and societies may supply resource people to speak to classes. They may also serve as hosts to student groups on field trips to study specific phases of the industry.

Instructors should be encouraged to become active members of these societies so that they may learn quickly of new technological developments. Membership will also enable them to meet people in the community who are most actively interested in the field. Some educational institutions pay all, or part, of the costs of membership dues and attendance at local or national meetings in order to encourage staff participation in selected societies.

Early in their studies, students should be required to become acquainted with the literature and services of scientific, technical, and engineering societies. They should also be encouraged to join those which offer affiliate memberships.

Many professional organizations and associations of manufacturers and producers serve the architect, scientist, engineer, technician, administrator, teacher, student, and all others dealing with architecture and building construction. For example, the American Institute of Architects (AIA) plays a leading role in development of architecture as a profession and in guiding educational programs. The AIA has an education committee in each local chapter which may offer assistance and guidance for programs.

Some other scientific, technical, industrial groups, and agencies whose publications and services interest teachers and students of architecture and building construction are:

Acoustical Society of America
American Concrete Institute
American Institute of Steel Construction
American Institute of Timber Construction
American Iron and Steel Institute
American Plywood Association
American Society of Civil Engineers
American Society of Landscape Architects
American Society of Testing Materials
American Society of Heating and Air Conditioning Engineers
Associated General Contractors of America, Inc.
Building Research Institute
California Redwood Association
Concrete Reinforcing Steel Institute
Construction Specifications Institute
Forest Products Laboratory
Institute of Electrical and Electronics Engineers
Lumber Dealers Research Council
Masonry Institute, Inc.
National Association of Home Builders
National Board of Fire Underwriters
National Bureau of Standards
National Concrete Masonry Association
National Electrical Contractors Association
National Electrical Manufacturers Association
National Lumber Manufacturers Association
National Ready Mixed Concrete Association
National Warm Air Heating and Air Conditioning Association
Portland Cement Association
Southern Pine Association
Steel Joist Institute
Superintendent of Documents (U.S. Government Printing Office)
Underwriters' Laboratories, Inc.
United States of America Standards Institute
West Coast Lumbermen's Association
Wire Reinforcement Institute

A brief description of some of these groups and their publications, as of 1965, is given in appendix A.

Advisory Committees and Services

The success of technician education programs depends, to a great extent, on the formal and informal support of advisory committees. When an institution decides to consider the advisability of initiating a particular technological program, the chief administrator or dean should appoint the advisory committee.

The special advisory committee for the architectural and building construction technology program should be comprised of representatives of employers and public employment services, scientific, or technical societies and associations in the field, architects and building construction engineers or their operating personnel, and knowledgeable civic leaders, who meet with and advise the specialists on the school's staff. Such members serve without pay as interested citizens. They enjoy no legal status, but provide invaluable assistance. The committee normally consists of about 12 members (but may range from 6 to 20), who generally serve for a 1- to 2-year period. The head of the institution or the department head of the technology is ordinarily chairman. Since such people are always busy, the meetings should be called only when committee action can best handle a specific task or problem.

The committee assists in surveying and defining the need for the technicians: the knowledge and skills they will require; employment opportunities; available student population; curriculum, faculty, laboratory facilities and equipment; cost and financing of the program. When the studies indicate that a program should be initiated, the committee's help in planning and implementing it is invaluable.

Frequently the committee substantially helps school administrators to obtain local funds and State and Federal support for the program. When the graduates seek employment, the committee aids in placing them in jobs and in evaluating their performance. Such evaluations often will result in minor modifications, which more closely relate the program to employment requirements.

The advisory committee can use this guide, designed primarily for planning and development of full-time preparatory programs in post high school institutions, as a starting point and modify it to meet local needs. The program can also form the basis for courses to meet the requirements of employed adults who wish to upgrade or update their skills and technical capabilities. In this way the school administration, with the help of the committee and special consultants, can effectively initiate the needed program, quickly develop it to a high level of excellence, and maintain its timeliness.

Very likely this guide will be adapted to suit various situations in schools in differing localities. The assistance of an advisory committee and of special consultants has been found to be of much value in initiating and developing programs. The courses in guides such as this one have often been modified by schools and their advisers to serve employed adults who need to update or upgrade their skills and technical capabilities.

The program is not intended to make an individual student proficient in all the duties he might be asked to perform. Proficiency in highly specialized work will come only with practice and experience. It is impossible to forecast the exact requirements of the duties assigned to any technician, and it is almost impossible to predict accurately the course or rate of change of various technologies. Employers generally recognize that the recent engineering graduates may require a year or more to obtain the specific training they need and to orient themselves to their responsibilities and role in an organization. Similarly, employers of newly graduated architectural or building construction technicians must generally expect to provide a 3- to 6-month period of orientation on the job. Furthermore, the productive graduate technician will continue to study throughout his career in order to develop to his fullest capabilities.

THE CURRICULUM

Course Requirements

	Hours per week			
Course	*Class*	*Laboratory*	*Outside study*	*Total*
First Semester				
Introductory Architectural Drawing	1	12	2	15
Technical Mathematics I	5	0	10	15
Applied Physics (Mechanics and Heat)	3	3	6	12
Building Materials and Construction Methods	3	3	6	12
Total	12	18	24	54
Second Semester				
Architectural Drawing and Model Building (Wood-Frame Structures)	1	9	2	12
Technical Mathematics II	4	0	8	12
Applied Physics (Electricity, Light, and Sound)	3	3	6	12
Communication Skills	3	0	6	9
Construction Planning and Control	3	0	6	9
Total	14	12	28	54

	Hours per week			
Course	*Class*	*Laboratory*	*Outside study*	*Total*
Third Semester				
Elementary Surveying	1	3	2	6
Advanced Architectural Drawing (Steel Structures)	1	9	2	12
Technical Reporting	2	0	4	6
Building Service Systems (Mechanical and Electrical)	3	3	6	12
Statics and Strength of Materials	3	3	6	12
History of Architecture and Construction	2	0	4	6
Total	12	18	24	54
Fourth Semester				
Advanced Architectural Drawing (Concrete Structures)	0	9	0	9
Contracts, Codes, Specifications, and Office Practices	2	0	4	6
Use of Computers and New Techniques	2	0	4	6
Industrial Organizations and Institutions	3	0	6	9
General and Industrial Economics	3	0	6	9
Building Construction Estimating	3	6	6	15
Total	13	15	26	54

Brief Description of Courses

Introductory Architectural Drawing

A course which introduces the student to general drafting techniques, such as lettering, line work, orthographic projection, perspectives, sections, and architectural conventions.

Technical Mathematics I

A course in algebra and trigonometry which presents the fundamental algebraic operations, the rectangular coordinate system, as well as fundamental trigonometric concepts and operations. The application of these principles to practical problems is stressed.

Applied Physics (mechanics and heat)

A course which introduces the student to basic principles of mechanics and heat. The subject matter covered should be related as much as possible to subjects in the architectural field.

Building Materials and Construction Methods

A course which familiarizes the student with the physical properties of the materials generally used in the erection of structures, with brief descriptions of their manufacture and use and laboratory study of materials and construction processes.

Architectural Drawing and Model Building (wood-frame structures)

A course which teaches the student how to prepare presentation drawings and working drawings of light structures from preliminary sketches. Principles of wood-frame construction are introduced. The student also acquires experience in using structural tables and manufacturers' literature. The program for this course includes construction of a scale model from developed working drawings.

Technical Mathematics II

A course to continue Technical Mathematics I. Topics in analytic geometry and the differential and integral calculus are studied.

Applied Physics (electricity, light, and sound)

A second course in physics presenting the basic principles of electricity, light, and sound correlated with technical mathematics and with corresponding topics as applied to buildings.

Communication Skills

A course in which the student gains experience in writing, speaking, and listening. Each student's strength and weakness are analyzed so that efforts may be made to remedy the deficiencies. Time allotments to the various elements of the course must be based on the class background. Technical reporting is introduced to aid the student in developing skill in communication.

Construction Planning and Control

A course in construction planning and control which deals with information on the materials, labor, and equipment necessary in the proper operation of a construction project The course covers the building construction procedures from preliminary site planning to final job inspection and introduces the methods of construction job scheduling. This course shows how the proper combination of men, material, and machines can be used to construct buildings successfully.

Elementary Surveying

A course which introduces the use of the engineer's level, transit, and common surveying instruments. Emphasis is placed on contour line determination and the staking for building layouts and grading.

Advanced Architectural Drawing (steel structures)

A course in steel-frame construction and typical details found in commercial structures. Study is made of shop drawings and their interrelationship to the entire building, emphasizing the need for the drawings for the complete structure to be developed logically, completely, and according to currently accepted practices.

Technical Reporting

A course in the practical aspects of preparing reports and communicating within groups, using the basic skills acquired in the previous course, "Communication Skills." The course includes the use of graphs, charts, sketches, and diagrams in presenting ideas and significant points orally or in formal or informal written reports.

Building Service Systems (mechanical and electrical)

An elementary study of mechanical and electrical systems used in buildings to provide comfort and utility within the structure. This course introduces the interrelationship of architecture and engineering considerations and functions.

Statics and Strength of Materials

A course which familiarizes the student with the mechanical properties of materials and the relationship and use of these materials in construction. Subjects include stress, deformation, member size and investigation, and connections. Typical members used in steel and in timber frameworks are studied, analyzed, and discussed.

History of Architecture and Construction

A study of the development of architectural form and use of materials and methods of construction. This course is a chronological study ranging from primitive architecture to complex modern engineered and computer-controlled building construction.

Advanced Architectural Drawing (concrete structures)

The last in a series of four courses, in drawing, providing further experience in the development of working drawings, with emphasis on reinforced concrete structures. The background from previous courses is utilized in developing a complete set of working drawings for a reinforced-concrete commercial structure.

Contracts, Codes, Specifications, and Office Practices

A study of the administration and operation of an architect's or engineer's office. Through the study of legal documents the student gains an insight into the restrictions, standards, and requirements established by law to govern the construction of buildings. The course emphasizes the interpretation and preparation of construction specifications employing accepted modern construction methods, materials, and practices.

Use of Computers and New Techniques

A course designed to inform the student about the new techniques being used by architectural offices to increase their efficiency. The course will identify and define the latest successful applications of data processing and other advances in technology to architecture and construction.

Industrial Organizations and Institutions

A study of roles played by labor and management in the development of American industry. Reference is made to the current aspects of an industrial society and the historical events leading up to it. Emphasis is placed on the legal framework within which labor-management relations and responsibilities are conducted in the democratic form of government.

General and Industrial Economics

A study of general economic principles and an analysis of the factors involved and importance of cost control in an industrial or public enterprise.

Building Construction Estimating

A course in which the student learns to estimate and prepare material and labor quantity surveys by making complete estimates from real working drawings and specifications.

Content and Relationships

Functional competence in a broad field such as architecture and building construction has at least three components around which the curriculum must be designed:

1. The training should prepare the graduate to be a productive employee in an entry-level job.
2. The broad technical training, together with a reasonable amount of experience, should enable the graduate to advance to positions of increasing responsibility.
3. The foundations provided by the training must be broad enough to enable the graduate to do further study within his field. This further study may consist of reading journals, studying text materials, or enrolling in formal courses.

This curriculum has been designed to meet these requirements.

A 2-year technology program has certain unusual requirements that influence the content and organization of the curriculum. Some of these requirements are imposed by the occupational functions that graduates are expected to perform; some requirements result from the emphasis of industry on particular areas of architecture or construction; some may be incidental to the need for special attention to content that will increase the effectiveness of teachers with special competencies; and others result from the limited time available to produce a competent technician in such a diverse field. This curriculum guide reflects three basic requirements: Functional utility, units of instruction in specialized technical subjects, and provision for the teaching of principles of application.

The sequence of courses in a 2-year technical curriculum is as important as the content of the courses if the limited time available is to be used most effectively. In general, the subject matter is carefully coordinated in groups of concurrent courses which are arranged to progress smoothly from one group of courses to the next. The student thus gains a deeper understanding of basic principles while broadening his scope of understanding in the many diverse areas of architecture and construction. This is in sharp contrast to the arrangement of the usual professional curriculum in which basic and somewhat unrelated courses make up the first part of the study program and specialization is deferred to subsequent terms.

The relationship between laboratory time and class lecture or theoretical study time is of great importance in a technical education curriculum. All of the theory, skills, techniques, applied principles, materials, information, and processes needed by the technician could be taught in the laboratory without separate and organized theoretical classes. The converse is *not true*—laboratory experience, skills, know-how, and capability which are the most characteristic attributes of technicians *cannot* be acquired in classrooms *without laboratories*. However, organized and related ideas, concepts, and factual information can be taught in "theory" classes, if the instructor judiciously uses demonstrations and visual aids, employs selected texts and references, and requires regular and systematic outside study by the student. Group teaching usually makes more efficient use of the instructor's time in a "theory" class than in a laboratory and tends to emphasize the development of the student's skills in obtaining knowledge from printed sources. Thus, there must be a special relationship between the amount of the scientific and technical specialty taught in the "theory" classes and that taught in the laboratory.

This curriculum devotes a large part of the time to laboratory hours in the technical specialty during the first two semesters because the student should acquire introductory and elementary laboratory skills and knowledge of apparatus, tools, processes, materials, devices and form good habits of practice in the laboratory as early as possible. Laboratory work can be started before the student knows much underlying theory. As soon as the underlying theory can be developed and he understands it, it can be incorporated into the laboratory work—which then becomes more significant in teaching the subjects in depth. Architectural drawing is emphasized especially because of the importance attached to it by many architectural and building construction employers.

Since many basic laboratory skills will have been learned in the first year, and since enough basic theory underlying the new material will have been required, the laboratory time required to illustrate principle and to teach new material in second-year courses need not be as long as in the first year. Since more technical specialty courses are studied in the second year than in the first, the total laboratory time is greater than that in the first year. Experience has shown that the relative number of semester hours of science or laboratory work in the technical specialty compared to class theory hours should not be reduced materially in teaching architectural and building construction technicians. Such a reduction usually causes the typical student to lose interest and fail or to abandon the course; or it produces a graduate who is deficient in the absolutely essential laboratory capabilities and is unemployable at the technical level.

In technical curriculums it is mandatory that some specialized technical course work be introduced in the first semester. Deferring this introduction even for one term imposes serious limitations on the effectiveness of the whole curriculum. An early introduction of the technical specialty has several important advantages:

1. It provides motivation. Since the student enrolled in school to study architectural and building construction technology, it is important to start his training immediately in his specialty. When the first semester consists entirely of general subjects—mathematics, English, social studies—technical students often lose interest.
2. It makes it possible for the student to achieve greater depth of understanding in specialized subjects in the later stages of the 2-year program.
3. It enables the student to see immediate application of the principles he studies in the mathematics, physics, and communication skills.

Safety and careful workmanship must be an underlying theme throughout the course of study. The technician's work often involves potential dangers that careful procedures combined with an understanding of the equipment and normal safety practice can avoid. In addition to protecting human life, eyes and body members, practice of careful workmanship will also protect the delicate apparatus (such as surveying instruments) the technician uses. Safety must be a constant preoccupation, and its practice must be emphasized continually from the beginning of the course.

Discipline in intellectual honesty must be a part of the training of any technician. He must report accurately what he observes. Any modification of the observed data should be fully explained in his record of the work. False reporting, if detected during the training of a technician, should be dealt with severely by the instructor. The original data recorded by an employed technician may become evidence in a court of law and are therefore of great importance.

Throughout the course of study the student is trained in the scientific method of observation and in recording his observations in laboratory reports. He should learn to record his observations in laboratory reports or surveying fieldbooks. Laboratory reports are bound, journal-type notebooks which the student is required to maintain throughout his experimental laboratory work. These reports carefully record data, computations, sketches, diagrams, and related information, as well as observations and conclusions of the experiment. Surveying fieldbooks are used to record all data taken from surveying instruments while the student is conducting field laboratory work. The logical method of recording data and information provides a discipline in the technical curriculum consistent with the needs of employed technicians.

From the total program the student should obtain a broad overview of architecture and building construction. Field trips to construction sites are helpful in creating interest by showing what architectural and building construction technicians do.

In the first semester the *Introductory Architectural Drawing* course begins to teach drawing and drafting skills and helps the student to see the need for the other basic courses. In the following semesters he must continually improve his skill in architectural representation and interpretation. The second semester drawing course in *Architectural Drawing* includes model building and introduces wood-frame construction.

The *Building Materials and Construction Methods* course introduces the technical specialty by providing for an intensive study of materials, processes, equipment, construction methods and techniques, and by enabling students to develop skill in the techniques to as high a degree as possible for the further study in the *Construction Planning and Control* course in the second semester.

Technical Mathematics I and *II* present a sequence of selected topics in algebra, trigonometry, analytical geometry, and calculus, which make up the mathematics courses. The inclusion of calculus in *Technical Mathematics* is not intended to make the student proficient in all aspects of the calculus but rather to help him to understand concepts which will permit him to use the calculus as a basic tool in analyzing problems and in communicating with engineers. The student's background in calculus should be broad enough to allow him to follow, though not necessarily reproduce, the development of equations which require the use of calculus. Examples might include the differentiation of elementary functions for determination of instantaneous velocities and accelerations which occur in the study of physics; and the use of calculus in the analysis of transient conditions and control systems.

Applied Physics (*mechanics and heat*) and *Applied Physics* (*electricity, light, and sound*) contribute to the student's essential understanding of the scientific principles in mechanics, levers, forces, light and heat transmission, and equilibrium. Laboratory work in the sciences and technical courses provides for practical demonstration and application of the principles he learned previously or is learning at the time.

The third semester's study is based on the student's accumulated knowledge of mechanics, heat, electricity, light, and sound and the basics of architecture. He extends and deepens his understanding of design and drawing in *Advanced Architectural Drawing* (*steel structures*) and learns the elements of steel structure design and construction. In *Elementary Surveying*, the student spends some time in studying the practice of architecture "on the ground," and learns the elements of laying out and staking for building sites. *Statics and Strength of Materials* introduces the study of structural members—drawing upon what the student has learned from *Applied Physics* (*mechanics and heat*) and *Building Materials and Construction Methods*. In the *History of Architecture and Construction* course, the student becomes familiar with the dynamic developments in architecture as primitive construction has evolved into today's professional practice. *Building Service Systems* (*mechanical and electrical*) teaches the elements of design and installation of heating, cooling, and service systems (such as elevators) necessary in a modern building.

The fourth semester provides for further depth of comprehension and practice in application of principles, techniques, skills, and concepts previously covered. *Advanced Architectural Drawing* (*concrete structures*) will further sharpen the student's skill in drafting as applied to the construction industry. *Contracts, Codes, Specifications, and Office Practices* shows the student how an architectural firm or a contractor's office must operate as a business. The course in *Use of Computers and New Techniques* introduces the student to modern electronic computer-controlled building construction, planning and control. In two courses, *Industrial Organizations and Institutions* and *General and Industrial Economics*, the student gains insight into the Nation's economic system, the working relationships between government and private industry, the importance of cost and economic accountability, and the interrelationships of labor and management. Finally, *Building Construction Estimating*, a summary course, compels the student to apply all that he has learned about construction methods, materials, and equipment by making *real* estimates from *real* specifications and drawings.

Close correlation of concurrent courses has not been stressed as strongly in the third and fourth semester courses as in the first and second semester courses, owing to the diverse areas of study in the second year. There is necessary overlap in course content throughout the second year, but in regularly scheduled planning sessions of the staff teaching concurrent second-year courses, the most effective material may be prepared for each course to minimize the duplication of material and loss of time.

Communication Skills emphasizes the mechanics of reading, writing, listening, speaking, and reporting early in the curriculum (second semester). In the third semester the student reinforces his skills in *Technical Reporting*. Instructors in technical courses should set increasingly high standards of clarity, conciseness, and neatness for student work in reporting. Freedom to report on technical subjects of their own choice may add reality and extra motivation for technology students. In the final phases of the 2-year program the standards of reporting should approximate those required by employers. At the same time instructors should encourage the student to develop individual style and initiative by allowing him as much freedom as possible in reporting, consistent with established school standards. Not all reports should be of a type which require a disproportionately large number of hours for preparation. The judicious use of informal reporting as well as formal reporting allows for training in both forms with the realism required in employment, and adjusts the time required of students in writing formal reports to a reasonable proportion of their time.

The course outlines included in this guide are concise and comprehensive, intended as guides rather than as specific plans of instruction to be covered in an inflexible order. They represent a judgment on the relative importance of each instructional unit, especially where time estimates are shown for the divisions within each course. The instructor is expected to supplement the principles outlined in these courses with practical applications whenever relevant. Field trips add greatly to the effectiveness of the instruction if they are carefully planned so that students understand the work, they observe and relate it to the subject material they are studying at the time of the trip. Operational safety should be emphasized in field trip studies, and liability insurance covering the students on such trips should be provided by the institution.

Outside study is a significant part of the student's total program. In this curriculum, *2 hours of outside study time are suggested for each hour of scheduled class time*. For example, a typical weekly work schedule for a student in the first semester of this curriculum would be: class attendance, 12 hours; laboratory, 18 hours; outside study, 24 hours—a total of 54 hours per week. This is a full schedule, but not excessive for this type of program.

Whenever possible, summer employment in the construction field should be arranged for the student between the second and the third semester. Often local architects or contractors will cooperate with such a program because they need relief operators during the vacation season. Some institutions may organize employment experience as a part of a cooperative plan.

Cooperative Education Plan

This technology is adaptable to a cooperative arrangement: a plan which offers important advantages to students, to the school, and to employers of technicians. A cooperative education program is a plan for a student to learn through coordinated study and employment experience. The student alternates periods of attendance at the institution where he is studying his technical education with periods of employment in business or industry. The employment constitutes an essential element in his education. The student's employment should be related as closely as possible to some phase of the field of study in which he is engaged.

When a student tests his knowledge of theory in a work situation, study becomes more meaningful. The co-op student learns not only the essentials of his technology but also the importances of reliability, cooperation, and judgment as an employed worker in his chosen field.

The co-op student's career choice is stimulated and shaped by his work experiences. If he finds satisfaction in his work, he returns to the classroom stimulated to learn as much as possible about his future career. If he finds through his work experience that he is not fitted to a specific area of work, he may decide to change his major field of study when he returns to the college. This decision may prevent him from wasting his time and money on a misguided choice of study.

A class of students in cooperative technical programs usually spends the first semester or the first two quarters in school; then it is divided so that half the students have a semester or quarter of employment experience while the other half continue to study. During the next semester or quarter, the half who have worked return to their formal studies at school while the other half are employed. They usually alternate again so that each student has two semesters or at least two quarters of work experience in his program. The student's technical program is lengthened beyond the curriculum outlined in this document by an amount of time equal to the total length of the employment experience.

Specific employment is obtained, as circumstances permit, by the educational institution with the cooperation of the student. The institution regards the work-experience program as an integral part of the technician program as a whole. It is not regarded primarily as an opportunity for earning, although each student while working is paid at the prevailing wage scale for the job he holds. Work reports by both the student and the employer are submitted to the school work program coordinator.

The cooperative work-experience program is an opportunity for the student to gain directly related experience which makes him more valuable as an employee. As a result of their work-experience in particular establishments, many students have been offered permanent positions upon completion of their schooling. Cooperating establishments agree, however, not to make offers of employment which become effective before the technician completes his program.

Cooperative programs provide opportunities for the educational institution to maintain close contact with employers in their various programs. This contact becomes a two-way channel of communication which helps the educational institution to keep its knowledge of specific employer needs in each technical field up to date, and at the same time keeps employers acquainted with and involved in the program of the institution.

Suggested Continuing Study

A 2-year curriculum must concentrate on the primary needs of science, mathematics, and the related knowledge and skills in the technical specialty necessary to preparing the student for employment upon graduation.

Obviously, a 2-year program cannot cover in depth all of the subjects pertinent to the technology; certain important, related subjects may only be touched upon. In addition, the graduate may obtain work in an area of the industry so new that adequate coverage in the training program has not yet been developed.

For these reasons, some form of continuation of study for graduates of technology programs is desirable. The student can keep abreast of the technical developments in his special field by reading the current literature related to the technology, by attending meetings of scientific and technical societies, and by study on his job. Such study tends to build on the organized, technological base provided by the curriculum he studied. Formal continuation of supplementary courses provides the most efficient and practical means for the graduate technician to add important knowledge and skill to broaden the base of his initial education. Formally organized courses have the advantages of systematic arrangement of subject matter, disciplined and competent teaching, and class discussion. They may be scheduled for evening or Saturday hours outside of the graduate technician's working day.

Rapid advances in architectural and building construction materials, methods, and systems and in areas related closely will require a continual updating of the employed graduate technician.

Some continued study suggested for the graduate in architectural and building construction technology might include the following fields or subjects:

- Advanced Study of Strength of Materials and Design
- Architectural Design
- Business Management, applied to the construction industry
- Civil Engineering, as related to construction
- Critical Path Planning of Construction
- Data Processing, for large construction companies
- Law, as applied to contracts and specifications
- Materials Testing and Specification Development, for new materials or construction methods
- Physics and Mathematics, as applied to architecture
- Soil Mechanics
- Specification Writing
- Subdivision Design
- Supervision and Management

COURSE OUTLINES

The courses outlined suggest the content which might be taught in the curriculum. The materials suggested provide a practical and attainable coverage of the field and have been reviewed by experienced instructors in successful educational programs for architecture and building construction technicians and by experts representing employers of such technicians.

Successful programs can be conducted as semester, quarter or trimester systems. The two-semester a year system illustrated in this document can be changed into three quarters or terms if advisable to meet community needs. Course content can be distributed over six quarters. For example, the four architectural drawing courses could be taught over six quarters since they progress from the elementary to the complex and cover specific information. They might be divided into six courses with appropriate subject names. The content of other courses might be redistributed to conform to a quarter system, but should offer no insurmountable obstacles since the total time in six quarters is the same as in four semesters.

The materials will very likely be modified to *fill local needs and to take advantage of special* interests and capabilities of the teaching staff; but the implied level, quality, and completeness of the program should not be compromised.

No examinations have been scheduled in the outlines. It is clearly intended that time be available for examinations. Therefore, a 17-week semester is assumed, and the outlines are designed to cover a full 16 weeks. The primary objectives of examinations would be to evaluate the student's knowledge and cause him to make a periodic, comprehensive review of the material presented in the course. The results of examinations may also point out weaknesses in teaching techniques or subject matter covered.

At the end of each course there is a list of text and reference materials. Each should be analyzed for its content and pertinency, and new and more suitable ones should be used if they are available. The information needed to cover a particular course in technician curriculums, particularly the technical specialty courses, is almost never available in one textbook; hence the multiple listing of references. They should usually be considerably augmented by current materials from manufacturers, trade journals, technical societies, and suppliers of equipment and materials in the special field of applied science being studied.

Suggested visual aids are listed for many courses. Each should be used when pertinent and when its use will teach more efficiently than any other method. *Excessive showing of films at the expense of well-prepared lectures and demonstration is to be avoided.* The suggested outside study periods may well be used instead of class lecture time for the showing of some films. All visual aids should be examined by the instructor before they are shown. Those listed after courses usually show name and address of supplier, size in mm., minutes required for showing, and whether they are sound or silent. This provides the necessary information for selection to fit projection equipment.

The experienced instructor is expected to make liberal use of charts, slides, models, samples, drawings, and specimens which illustrate special technical aspects of the subject. He usually accumulates them from the experience in previous laboratory or lecture preparations and updates regularly when new developments require it. They are too specific for any attempt to be made to list them in this suggested guide.

The laboratory sessions suggested in the outline and in the course descriptions are not intended to be a single session but rather to be scheduled in reasonable and effective increments. For example, a 9-hour laboratory total per week for a course might be scheduled as three 3-hour sessions, or any other divisions of laboratory time that seem appropriate.

INTRODUCTORY ARCHITECTURAL DRAWING

Hours Per Week

Class, 1; Laboratory 12

Description

This course introduces representation in construction. It covers the fundamentals of drafting, including projection, sectioning, pictorial drawings, perspective, shades, shadows, and architectural representation.

After principles have been introduced, exercises involving each principle are drawn.

Applicable exercises in freehand techniques are also required to develop facility in freehand expression.

If possible, the weekly lecture period should precede one of the laboratory periods, and the lecturing should be done before students have their drawing equipment in place. Lectures are more difficult when students have become involved in making their drawings. Topics that are introduced in the lecture should require additional outside reading by the student.

Drawing exercises must be carefully supervised by the instructor when basic graphic concepts are involved. Later exercises, possibly involving creative work, should allow students to think on their own, even if completion of a project requires the students to work outside of the allotted laboratory time. Students in architectural drawing must be motivated to develop creative talents, beginning in this first course.

Early exercises which provide for experience in the basic principles must also develop drafting discipline in linework, lettering, geometric relationships, measuring, and projection principles. Linework not only must be accurate but must be expressive and dark enough to reproduce on the various types of machines. Exercises should be oriented to architectural subjects as much as possible and should progress from the simple to the more complex.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Orientation and Use of Instruments	1	6
II. Lettering and Lettering Devices	1	15
III. Geometric Construction	1	12
IV. Orthographic Projection, Points, Lines, and Planes	2	24
V. Dimensioning, Scales, and Material Symbols	1	12
VI. Sections and Cutting Planes	2	30
VII. Auxiliary Views	1	9
VIII. Pictorial Drawings—Isometric, Oblique, and Perspective	3	30
IX. Shades and Shadows of Orthographic and Perspective Drawings	1	18
X. Architectural Applications of Basic Concepts	2	18
XI. Freehand Sketching of Various Types of Drawings	1	18
Total	16	192

I. Orientation and Use of Instruments

A. Units of instruction
1. Lecture on class procedure, method of grading, assignments, and general orientation
2. Lecture and demonstration on correct use and care of drawing instruments and equipment
    a. Line quality
    b. Accuracy in measuring

    c. Neatness in work
    d. Dexterity with instruments
    e. Use of templates
  B. Laboratory
    1. Drawing of elementary exercises involving simple lines and measuring to acquaint students with the correct use of equipment
    2. Supervision of student procedures to insure formation of correct habits (for example—the correct method of using triangles and T-squares in drawing vertical lines)

II. Lettering and Lettering Devices
  A. Units of instruction
    1. Basic technical alphabet (capitals)
      a. Proportion
      b. Direction and sequence of strokes
      c. Spacing of characters and words
    2. Letter heights and use of lettering guide
    3. Alphabet classification
      a. Capitals and lower case
      b. Condensed and expanded
      c. Lightface and boldface
    4. Titles and title blocks
      a. Letter sizes
      b. Laying out symmetrical titles
    5. Variations of technical alphabets
      a. Vertical and inclined
      b. Architectural
      c. Display
      d. Use of transfer letter sheets
  B. Laboratory
    1. Freehand lettering of basic technical lettering (large size to ensure correct formation and stroke sequence)
    2. Exercises in small lettering (⅛-inch high)
    3. Exercises in laying out titles
    4. Exercises in architectural variations
    5. Exercises in lower case lettering, including numerals and fractions
    6. Instructor criticism of student lettering—weaknesses and faults

III. Geometric Construction
  A. Units of instruction
    1. Dividing lines with instruments
    2. Intersections of lines and arcs
    3. Intersections of arcs
    4. Drawing basic geometric forms
    5. Drawing angles with instruments
  B. Laboratory
    1. Exercises in the conventional geometric intersections and shape drawings, with emphasis on accuracy and drafting discipline
    2. Exercises in plane figures requiring the use of the various geometric constructions

IV. Orthographic Projection, Points, Lines, and Planes
  A. Units of instruction
    1. The theory of projection
      a. The quadrants
      b. The conventional "glass box"
      c. Projectors
    2. Orthographic projection
      a. Relationship of views
      b. Planes of projection
      c. Selection of views
      d. Appearance of various surfaces
      e. Hidden surfaces
      f. Layout of a multiview drawing
    3. Points, lines, and planes
      a. Locating a point in space
      b. Locating a line in space
      c. Locating a plane in space
  B. Laboratory
    1. Freehand exercises on coordinate paper of orthographic views (use pictorial objects)
    2. Exercises in orthographics of missing view drawings
    3. Orthographic problems drawn with instruments
    4. Exercises in locating points, lines, and planes on three views

V. Dimensioning, Scales, and Material Symbols
  A. Units of instruction
    1. Use of architects' and engineers' scales
    2. Principles of dimensioning technical drawings
      a. Dimension lines, arrowheads, leaders
      b. Size dimensions
      c. Location dimensions
      d. Architectual dimensioning conventions
      e. Notes
    3. Material symbols used on drawings
  B. Laboratory
    1. Exercises requiring student to complete problems at scales other than full size
    2. Exercises requiring correct dimensioning—selection and placement

VI. Sections and Cutting Planes
  A. Units of instruction
    1. Types of sections
    2. Purpose of sections

      3. Cutting-plane theory
      4. Conventions in sections
      5. Symbol hatching
      6. Architectural section variations
         a. Plans
         b. Vertical sections
   B. Laboratory
      1. Simple exercises involving the basic types of section
      2. Exercises involving nearly complete objects, with voids and surfaces beyond the cutting planes
      3. Exercises in architectural sections involving several materials in the construction

VII. Auxiliary Views
   A. Units of instruction
      1. Use of auxiliary views
      2. Relationship of auxiliary planes to principal planes of projection
      3. Construction of auxiliary views
      4. Intersections of oblique planes and cones, cylinders, and curved surfaces
      5. Architectural applications
   B. Laboratory
      1. Exercises in auxiliary surfaces (drawing true shapes from orthographic views)
      2. Drawing of a practical problem involving true length of hip rafter in hip roof
      3. Exercises in intersections of planes and various figures

VIII. Pictorial Drawings—Isometric, Oblique and Perspective
   A. Units of instruction
      1. Theory of isometric drawing
         a. Angles of planes
         b. Relationship to orthographic views
         c. Methods of construction, drawing isometric circles
      2. Theory of oblique drawing
         a. Variation of axis
         b. Selection of views
         c. Application to architectural representation
      3. Isometric and oblique sections
      4. Dimensioning pictorial drawings
      5. Perspective drawings
         a. Theory of perspective
         b. Nomenclature; variables
         c. Office method
            (1) Two-point angular
            (2) One-point parallel
         d. Perspective plan method
            (1) Measuring lines
            (2) Slope vanishing points
   B. Laboratory
      1. Exercises in drawing isometric drawings from orthographic views
      2. Exercises in drawing oblique drawings from orthographic views
      3. Exercises in angular perspective (office method)
      4. Exercises in parallel one-point perspective
      5. Exercises in perspective plan method involving measuring lines and slope vanishing points

IX. Shades and Shadows of Orthographic and Perspective Drawings
   A. Units of instruction
      1. Application and use of shadows
      2. Conventional light source, 45°
      3. Theory of orthographic shadows
      4. Constructing orthographic shadows of typical architectural subjects
      5. Theory of shadows on perspective drawings
         a. With the light source parallel to the picture plane
         b. With the light source oblique to the picture plane
      6. Shadows on plot plans
   B. Laboratory
      1. Exercises in projecting shadows on plan and elevation views
      2. Exercises in plotting shadows on perspective drawings—parallel light sources (using drawings previously done in perspective)
      3. Exercises in plotting perspective shadows on buildings with an oblique light source

X. Architectural Applications of Basic Concepts
   A. Units of instruction
      1. Terminology in architectural projection
      2. Conventional "plan" views
      3. Architectural technique in line work, dimensioning, and lettering
      4. Elevation views
      5. Use of section views in architectural drawing details
   B. Laboratory
      1. Exercises in drawing simple residential plan using conventional architectural technique, symbols, and dimensioning

  2. **Exercises in simple elevations with the introduction of orthographic shadows**
  3. **Exercises in typical architectural details—sections**

XI. Freehand Sketching of Various Types of Drawings

- **A. Units of instruction**
  1. **Materials for sketching**
  2. **Purpose and value of skill in sketching freehand**
  3. **Techniques used as sketching aids**
     - **a. Dividing lines**
     - **b. Proportion**
     - **c. Sketching geometric forms**
     - **d. "Blocking in" subjects**
     - **e. Shading and linework**
  4. **Sketching isometric and oblique**
  5. **Sketching in perspective**
- **B. Laboratory**
  1. **Exercises in sketching simple plans over coordinate paper**
  2. **Exercises in sketching elevation views**
  3. **Exercises in sketching section details**
  4. **Exercises in sketching isometric and oblique pictorial drawings**
  5. **Exercises in sketching "thumbnail" perspectives**

Texts and References

French *and* **Vierck.** ***Fundamentals of Engineering Drawing.***
Giesecke *and* **others.** ***Technical Drawing.***
Hepler *and* **Wallach.** ***Architecture; Drafting and Design.***
Luzadder. ***Fundamentals of Engineering Drawing.***
Martin. ***Design Graphics.***
Muller. ***Architectural Drawing and Light Construction.***
Patten *and* **Rogness.** ***Architectural Drawing.***

ARCHITECTURAL DRAWING AND MODEL BUILDING (WOOD-FRAME STRUCTURES)

Hours Per Week

Class, 1; Laboratory, 9

Description

This is the second of four drawing courses. It introduces residential design and wood-frame construction and requires the student to study additional aspects of housing, aesthetics, and working drawings. The graphic methods of representation the student has acquired in Introductory Architectural Drawing are strengthened in this course, but more emphasis is placed on creativity. He completes a practical residential design problem, which provides him with the groundwork for a professional attitude.

Beginning lectures should be devoted to residential planning—including information on interior space utilization, traffic patterns, exterior materials, and good taste in home styling. Later lectures include wood-frame construction methods, aspects of footings and foundations, and available materials and equipment for residences. Emphasis should be placed on good construction details and on the reason why one method of construction would be more satisfactory than another.

This course should encourage the student to use manufacturer's literature, Sweet's Catalog Service, and other reference material and to investigate local building codes and make drawings that comply with them. He should have access to a drafting room with large (3 by 5 feet) drafting tables and to model-building tools.

Early studies should begin with sketches which the instructor continually reviews to aid students in solving their problem graphically before they do the final drafting on the board.

Working drawings should be made on suitable sizes of tracing paper so that trial prints may show reproduction qualities. Presentations should be done on illustration board for display purposes.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Orientation; Residential Planning and Design	3	12
II. Presentation Drawings and Rendering Techniques	3	30
III. Wood-Frame Construction—Working Drawings and Details	8	72
IV. Architectural Model-Building	2	30
Total	16	144

I. Orientation; Residential Planning and Design

- A. Units of instruction
  - 1. Class procedure and objectives
  - 2. Residential planning
    - a. Scope
    - b. Housing costs
    - c. Property physical characteristics; codes
    - d. Housing styles
    - e. Structural types
    - f. Floor plan development
      - (1) Square footage
      - (2) Traffic flow and patterns
      - (3) Living spaces
      - (4) Kitchen and bath layouts
      - (5) Storage
    - g. Elevation design
      - (1) Choice of materials; aesthetics
      - (2) Fenestration
      - (3) Roof types and coverings
      - (4) Cornice treatments and overhangs
    - h. Landscaping

B. Laboratory

1. Beginning exercises should consist mainly of sketches. Students should get a practical residential design problem, indicating the square footage required, type of family to occupy the home, and other definite requisites of the problems. First sketches should be floor-plan sketches, until a satisfactory plan has been developed.
2. Students should sketch various elevations to accommodate the developed plan, and sketch typical sections of proposed wall construction.
3. The instructor must supervise sketches to insure that ideas are compatible and that students make consistent progress toward the solution of the problem.

II. Presentation Drawings and Rendering Techniques

A. Units of instruction

1. Purpose of presentations
2. Architectural composition
   - a. Balance, tone, value, and emphasis
   - b. Spaces, shapes, and textures
3. Pencil rendering
   - a. Architectural materials
   - b. Light and shade
   - c. Foliage representation; people and autos
4. Pen and ink rendering
   - a. Architectural materials
   - b. Line work; light and shade
   - c. Overlay tone work-sheets
   - d. Foilage
5. Color techniques
   - a. Colored pencil
   - b. Pastel
   - c. Water color

B. Laboratory

1. Students perform exercise in the various media.
2. A finished presentation is made of the residential problem previously developed.
3. A criticism is made of the completed presentation.

III. Wood-Frame Construction—Working Drawings and Details

A. Units of instruction

1. Characteristics of wood-frame construction
   - a. Western frame
   - b. Balloon frame
   - c. Post-and-beam
   - d. Trussed-rafter framing
   - e. Crawl-space; slab-on-grade
   - f. Footings and foundations
   - g. Roof types and framing
   - h. Siding types and selection
   - i. Ventilation of structures
2. Bearing-wall construction
   - a. Concrete block
   - b. Brick
     - (1) Solid
     - (2) Brick cavity
   - c. Stone masonry
   - d. Other masonry
3. Working drawings
   - a. Frame construction
   - b. Masonry
   - c. Dimensioning
   - d. Symbols
   - e. Electrical plans and layouts
   - f. Heating and cooling plans
   - g. Typical wall sections
   - h. Interior elevations
   - i. Special construction
   - j. Organizing sheet layouts or working drawings

B. Laboratory

Laboratory periods are devoted to the development of the complete set of working drawings for the original residential design. These working drawings should be made on *22 by 34 inch tracing paper suitable for reproduction*. A uniform title block and border should be used on each sheet. All work should be done with instruments on large (3 by 5 feet) drafting tables.

The following drawings or sets of drawings should be made:

1. Plot plan showing house locations and other pertinent features (suitable scale)
2. Foundation plan or basement plan (¼ inch = 1 foot)
3. Floor plan (¼ inch = 1 foot)
4. Four elevations (¼ inch = 1 foot)
5. Typical wall section; window and door schedule
6. Interior kitchen and bath elevations (½ inch = 1 foot)
7. Other required sections and details

IV. Architectual Model Building

- A. Units of instruction
  1. Purpose of models
  2. Types of models
     - a. Architectural
     - b. Structural
  3. Construction techniques
  4. Use and safety of conventional woodworking tools and machines
- B. Laboratory
  1. Make a model of a wood frame residence. A residential design should be selected by the instructor for the model building. The class should be divided into groups or crews of from five to eight for each model. The student originating the selected design should act as crew chief to supervise and help plan the construction. Reference should continually be made to the set of working drawings done by the student while working on the models. Omissions and errors in the drawings will readily become apparent.

     If facilities are available, the model should be built to scale structurally. Each structural member should be made and assembled as in actual construction. (Suggested scale: ½ inch = 1 foot.)
  2. Add complete landscaping to the model. If woodworking facilities are not available, architectural models involving only exterior appearance rather than the complete structure should be made as an alternate. Balsa wood or illustration board walls can be sized and painted or finished to resemble the required exterior appearance.

Texts and References

FAULKNER *and* FAULKNER. *Inside Today's Home.*
HALSE. *Architectural Rendering.*
MULLER. *Architectural Drawing and Light Construction.*
SMITH. *Principles and Practices of Light Construction.*
SWEET'S CATALOG SERVICE. *Architectural File.*
TOWNSEND *and* DALZELL. *How to Plan a House.*

ADVANCED ARCHITECTURAL DRAWING (STEEL STRUCTURES)

Hours Per Week

Class, 1; Laboratory, 9

Description

The third drawing course introduces steel frame buildings, commercial or institutional, and the problems involved in their representation. Steel frame terminology, fundamentals of design elements, typical details, framing plans, shop drawings, as well as the architectural design drawings, are covered so that students may have the "total" experience required in making the working drawings for steel frame buildings.

Information is presented during lecture periods just as it is in previous drawing courses, and specialized topics are introduced during laboratory periods. Early exercises might best start with design information furnished by the instructor; later exercises should require the student to look up information in the *Manual* of the American Institute of Steel Construction (AISC), and other handbooks. After terminology, structural steel symbols, and typical details are introduced, a lecture period should be devoted to the conventional methods of selecting the necessary sections and details to be drawn and the system of showing related framing plans and schedules to make a logical, well-laid-out drawing.

All drawings should be made with pencil on tracing paper. Toning of views for easier interpretation may be done on the reverse side of the paper. Each student's work should be reproduced by blueprint or blueline machine or other reproduction methods to show its reproductive qualities.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Orientation; Structural Steel Terminology, Steel Drafting Conventions, Manufacture and Properties of Steel, Methods of Fabrication and Erection	2	12
II. Typical Details—Riveted, Bolted, and Welded Connections, Columns, and Special Connections	6	30
III. Details of Minor Structural Features	2	28
IV. Shop Drawings Related to Heating and Cooling Equipment in Commercial Buildings	3	26
V. Planning and Drawing the Working Drawings for a Small Commercial Building	3	48
Total	16	144

I. Orientation; Structural Steel Terminology, Steel Drafting Conventions, Manufacture and Properties of Steel, Methods of Fabrication and Erection

- A. Units of instruction
  - 1. Class procedure and objectives
  - 2. Structural steel terminology and abbreviations
  - 3. Steel manufacture and fabrication
    - a. Structural steel properties; sizes and weights
    - b. Fabrication layout—templates
    - c. Punching, drilling, and reaming

- d. Cutting, sawing, and shearing
- e. Rolling, bending, and straightening
- f. Milling and finishing; riveting and welding
- g. Cleaning, painting, marking, and inspection

4. Structural steel drafting conventions
    - a. Symbols for fasteners
    - b. Symbols for typical steel shapes
    - c. Types of steel drawings
        - (1) Preliminary plans and layouts
        - (2) Projections and sections
        - (3) Framing plans
        - (4) Column schedules
        - (5) Erection schedules and diagrams
    - d. Conventions of linework
        - (1) Center-lines and break-lines
        - (2) Cutting-plane lines
        - (3) Match-lines and gage-lines
    - e. Selection and orientation of required views
        - (1) Scales
        - (2) Location and layout
        - (3) Symmetry
        - (4) Relating views for easy interpretation

B. Laboratory

1. Make drawings of simple sections and details to acquaint students with conventional steel symbols—riveted, bolted, and welded.
2. Draw problems of various steel shapes taken from the *AISC Manual*.
    - a. Steel beam with riveted connection
    - b. Steel wide-flange column
    - c. Angle connection detail
3. Copy the beam details from a given drawing in the *AISC Manual*.
4. Draw a detail showing both shop connections and field connections.

II. Typical Details—Riveted, Bolted, and Welded Connections, Columns, and Special Connections

A. Units of instruction

1. Design drawings and shop drawings
2. Beam detailing connections
3. Size and bolted connections
    - a. Size and spacing
    - b. Allowable loads of rivets and bolts in shear and bearing
    - c. Simple framed connections
    - d. Beam-to-column connections
    - e. Seated connections
    - f. Stiffened seated connections
4. Welded connections
    - a. Types
        - (1) Butt
        - (2) Fillet
    - b. Strength and allowable loads
    - c. Beam-to-girder connections
    - d. Beam-to-column connections
5. Column details
    - a. Framing plans and schedules
    - b. Splices
    - c. Column base plates
    - d. Shear connections
    - e. Right- and left-hand details
    - f. Special connections
        - (1) Staggered
        - (2) Offset
        - (3) Inclined
6. Dimensioning methods and clearance for field work
7. Marking, assembly, and erection

B. Laboratory

1. Draw typical problems using riveted, bolted, and welded connections.
2. Draw problems involving the use of handbooks in designing and selecting riveted connections.
3. Draw problems involving the use of handbooks in designing and selecting bolted connections.
4. Draw problems of column layouts with schedules.
5. Draw problems involving special connections
    - a. Framed and seated connections
    - b. Stiffened and unstiffened riveted connections
    - c. Right- and left-hand connections

III. Details of Minor Structural Features

A. Units of instruction

1. Types of steel trusses, gusset plates, and fasteners
2. Steel stair, details and drawings
3. Concrete floors in steel frame and roof decks
    - a. Steel forming, corrugated metal
    - b. Open-web joists
    - c. Bearing-wall details
4. Typical curtain-wall details

B. Laboratory
  1. Draw the necessary views of a steel truss. Make a bill of material.
  2. Design steel stairs and show the necessary details.
  3. Draw various masonry floor details and indicate the selected forming material.
  4. Draw a brick bearing-wall detail and show the use of an open-web roof joist.
  5. Draw several typical curtain-wall details used in steel frame construction.

IV. Shop Drawings Related to Heating and Cooling Equipment in Commercial Buildings

A. Units of instruction
  1. Architectural considerations
    a. Space required for equipment
    b. Insulation and material selection
    c. Accommodating equipment and ductwork in structure
  2. Conventional heating-cooling symbols, terminology, and drawings
  3. Procedures in sizing sheet metal ductwork and registers
  4. Piping drawings related to heating-cooling

B. Laboratory
  1. Draw problems to introduce the symbols and conventions on heating-cooling shop plans.
  2. Draw the ductwork and register indications on a typical floor plan.
  3. Plan the heating-cooling system for a small commercial building, and select the necessary equipment from manufacturer's catalogs.

V. Planning and Drawing the Working Drawings for a Small Commercial Building. (For this project the instructor will furnish a small-scale floor plan, elevation, and framing plan for students.)

A. Units of instruction
  1. Group discussion of the general problems involved and the conventional procedures in solving the problems
  2. Discussion of the necessary drawings and details required; representing the building on working drawings
  3. Arriving at solutions by trial-and-error
  4. Planning the layout of the set of drawings

B. Laboratory
  1. Devote the early laboratory periods to freehand sketches of preliminary ideas (schematic plan to be furnished by instructor before students begin actual instrument drawings).
  2. Sheet layouts planned to determine scales.
  3. Make necessary drawings and details at proper scales on tracing paper; finish set of working drawings.

Texts and References

AMERICAN INSTITUTE OF STEEL CONSTRUCTION. *Manual of Steel Construction; Structural Shop Drafting.*

BATEMAN. *Materials of Construction.*

HUNTINGTON. *Building Construction.*

JENSEN *and* CHENOWETH. *Applied Strength of Materials.*

MERRITT. *Building Construction Handbook.*

SWEET'S CATALOG SERVICE. *Architectural File.*

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, OFFICE OF EDUCATION. *Civil Technology, Highway and Structural Options, A Suggested 2-Year Post High School Curriculum.*

ADVANCED ARCHITECTURAL DRAWING (CONCRETE STRUCTURES)

Hours Per Week

Class, 0; Laboratory, 9

Description

This last architectural drawing course will enable the student to have further experience in preparing working drawings of commercial structures with specific application to reinforced concrete. Principles of reinforced concrete are introduced to provide him with a background in the standards and the conventions of logical detailing.

More of the planning is left to the student than in earlier courses, yet emphasis is placed on the interrelation of the various types of drawings required and the clear development of the complete architectural plan.

Although a formal class-lecture period is not shown for this course, group discussions (especially during early periods) must be conducted. The discussions should be held when students begin laboratory work on the various problems. Half-hour discussions may be most satisfactory. The instructors should insist that students make preliminary sketches and develop them before permitting the preparation of final working drawings. Professional standards of drafting should be maintained.

Major Divisions

	Laboratory hours
I. Symbols, Conventions, Standards of Reinforced Concrete Drawings	16
II. Typical Details	36
III. Precast and Prestressed Concrete	20
IV. Shop Drawings of Plumbing and Electrical Equipment	20
V. Preparation of the Working Drawings of a Simple Reinforced Concrete Building	52
Total	144

I. Symbols, Conventions, Standards of Reinforced Concrete Drawings

- A. Make standard sections and views
  - 1. Abbreviations and symbols
  - 2. Selection of views
  - 3. Codes
- B. Make engineering and placement drawings
  - 1. Reinforcement
  - 2. Bends and bar supports
  - 3. Columns and splices
- C. Illustrate marks and schedules
  - 1. Beams
  - 2. Columns
  - 3. Reinforcement
- D. Prepare bar lists and specifications
- E. Prepare drawing exercises of introductory material
- F. Discuss and illustrate computer detailing schedules

II. Typical Details

- A. Draw concrete floor joists
- B. Draw flat-slab floor
- C. Draw a waffle flat-slab floor
- D. Draw a beam-and-girder floor
- E. Draw a two-way flat and beam floor
- F. Draw foundations and columns
- G. Draw wall details
- H. Draw stair details
- I. Make a welded wire fabric drawing

III. Precast and Prestressed Concrete

- A. General principles: Make drawings of the following:
  - 1. Precast reinforced concrete
    - a. Typical detail problems
    - b. Floor plans
    - c. Fabrication details
  - 2. Prestressed concrete
    - a. Precast and cast in place
    - b. Typical building details
    - c. Roof details
  - 3. Concrete bridge details
- B. Detailing procedure. Make detail drawings of members:
  - 1. Precast
  - 2. Prestressed

IV. Shop Drawings of Plumbing and Electrical Equipment
  A. Plumbing drawings. Make example drawings showing:
    1. Symbols and abbreviations
    2. Typical details
    3. The plumbing plan
  B. Electrical drawings. Make example drawings showing:
    1. Conventional symbols and abbreviations
    2. Typical details
    3. The electrical plan

V. Preparation of the Working Drawings of a Simple Reinforced Concrete Building. (Small-scale architectural floor plan, elevations, and framing plan should be furnished by the instructor. For variety, a type of commercial building different from that used in the previous course should be furnished.)
  A. Make preliminary sketches:
    1. Proposals
    2. Drawing of set layouts and scales
  B. Make instrument drawings of required plans, details, and schedules
  C. Evaluate and criticize the finished work

Texts and References

American Concrete Institute. *Manual of Standard Practice for Detailing Reinforced Concrete Structures.*
Dunham. *The Theory and Practice of Reinforced Concrete.*
Howard. *Structure, an Architect's Approach.*
Larson. *Portland Cement and Asphalt Concretes.*
Lin. *Design of Prestressed Concrete Structures.*
McKaig. *Applied Structural Design of Buildings.*
Munce. *Industrial Architecture.*
Preston. *Practical Prestressed Concrete.*
Salvadori *and* Levy. *Structural Design in Architecture.*
U.S. Department of Health, Education, and Welfare, Office of Education. *Civil Technology, Highway and Structural Options, A Suggested 2-Year Post High School Curriculum.*
Wang *and* Salmon. *Reinforced Concrete Design.*
Winter *and* others. *Design of Concrete Structures.*

BUILDING CONSTRUCTION ESTIMATING

Hours Per Week

Class, 3; Laboratory, 6

Description

This course introduces the student to the basic methods of estimating and develops a system for doing quantity surveys. The course also prepares the student to make some of the kinds of estimates that are commonly used in architectural and building construction.

Lecture periods are used to show the student different methods of estimating for each of the major elements which will be prepared in detail in the laboratories to follow. The class should be divided into three- or four-man groups; each group should be issued a set of drawings and specifications from which to work.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Introduction to Estimating	6	18
II. Excavation	4	6
III. Foundations and Concrete	4	6
IV. Masonry	5	12
V. Waterproofing and Dampproofing	2	3
VI. Wood Construction and Roofing	6	12
VII. Structural Steel and Sheet Metal	3	6
VIII. Lathing and Plastering	3	6
IX. Doors, Windows, and Hardware	3	3
X. Painting, Papering, and Glazing	3	6
XI. Plumbing	3	6
XII. Heating and Air Conditioning	3	6
XIII. Electrical	3	6
Total	48	96

I. Introduction to Estimating

A. Units of instruction

1. Kinds of estimates
    - a. Detailed
    - b. Unit-quantity
    - c. Total-quantity
    - d. Approximate or shortcut
    - e. Complete
    - f. Quantity survey
    - g. Contractors' estimates
    - h. Architects' or engineers' estimates
    - i. Progress
    - j. Final estimates
2. Qualifications of an estimator
3. Preliminary investigations (visiting the site)
4. Five subdivisions of estimating
    - a. Materials
    - b. Labor
    - c. Plant
    - d. Overhead
    - e. Profit
5. Sources of error
6. Checking the estimate

B. Laboratory

1. Mensuration; solve sample problems in:
    - a. Linear measure
    - b. Square measure or measures of surfaces
    - c. Cubic measure or cubical contents
    - d. Computation of area of a square; rectangle or parallelogram
    - e. Computation of area of a triangle
    - f. Computation of circumference of a circle
    - g. Computation of area of a circle
    - h. Computation of cubical contents of a circular column
    - i. Computation of cubical contents of any solid
    - j. Computation by decimal system of numerals in estimating
    - k. Computation of board feet

II. Excavation

A. Units of instruction

1. Cross-sectioning method
2. Borrow-pit method

B. Laboratory
    1. Work a problem using the cross-sectioning method from a topographical survey.
    2. Work a problem using the borrow-pit method from a topographical survey.

III. Foundations and Concrete
  A. Units of instruction
    1. Piling and bracing
    2. Footing in cubic yards
    3. Forms in square feet of form surface
    4. Walks, drives, retaining walls, floors, roofs, columns, beams, etc., in cubic yards or cubic feet of concrete
    5. Reinforcing steel in pounds or tons
    6. Finishing concrete in square feet or square yards
    7. Curing concrete in cubic yards or cubic feet or in square yards or square feet
  B. Laboratory
    Working from a set of working drawings and specifications, make quantity surveys for the following:
    1. Footings
    2. A formed foundation wall
    3. Amount of steel in a concrete slab and columns
    4. Finishing concrete

IV. Masonry
  A. Units of instruction
    1. Brick masonry and mortar
    2. Stone masonry and mortar
    3. Concrete block, brick, and tile masonry
    4. Hollow clay tile (terra-cotta) masonry
    5. Gypsum block and tile masonry
    6. Architectural terra-cotta
  B. Laboratory
    1. Prepare a quantity survey of a brick veneer wall from a set of working drawings and specifications.
    2. Prepare a quantity survey of a stone masonry retaining wall.
    3. Prepare a quantity survey of a concrete block foundation wall, and a ceramic tile bathroom wall.
    4. Prepare a quantity survey of an 8-inch, load-bearing tile wall.
    5. Prepare a quantity survey for a steel column by using fire-proofing tile.
    6. Prepare a quantity survey of a coping on a parapet wall.

V. Waterproofing and Dampproofing
  A. Units of instruction
    1. Painting with water-resisting paint or compound
    2. Plastering with water-resisting mortar
    3. Integral waterproofing by adding powder or compounds
    4. Placing of membranes
  B. Laboratory
    Prepare a quantity survey of a basement wall using:
    1. Two layers of felt and three coats of asphalt.
    2. An outside membrane and water-resisting paint.

VI. Wood Construction and Roofing
  A. Units of instruction
    1. Rough carpentry
    2. Millwork and interior finish
    3. Roofing
  B. Laboratory
    1. Prepare a quantity survey of the rough carpentry for a one-story residence.
    2. Prepare a quantity survey for an asphalt-strip shingle roof for a one-story building.

VII. Structural Steel and Sheet Metal
  A. Units of instruction
    1. Estimating of structural steel
    2. Estimating of sheet metal
  B. Laboratory
    1. Prepare a quantity survey of a small, structural-steel frame building
    2. Prepare a quantity survey for a one-story residence for the following sheet metal work:
      a. Gutters and leaders
      b. Flashing
      c. Termite shields

VIII. Lathing and Plastering
  A. Units of instruction
    1. Kinds of lathing and uses
    2. Kinds of plastering and uses
  B. Laboratory
    1. Prepare a quantity survey for a one-story residence, using gypsum lath and metal lath for bathroom
    2. Prepare a quantity survey for a one-story residence, using a three-coat plastering job.

IX. Doors, Windows, and Hardware
- A. Units of instruction
  - 1. Kinds of doors and uses
  - 2. Kinds of windows and uses
  - 3. Selection of hardware
- B. Laboratory

  Working from schedules and specifications, do a quantity survey for:
  - 1. Doors
  - 2. Windows
  - 3. Hardware

X. Painting, Papering, and Glazing
- A. Units of instruction
  - 1. Kinds of paints and uses, and methods used in estimating
  - 2. Papering, sizing, and paste
    - a. Where used
    - b. Methods used in estimating
  - 3. Glazing
    - a. Kinds of glass
    - b. Methods used in estimating
- B. Laboratory
  - 1. Prepare a quantity survey for a one-story residence for interior painting
  - 2. Prepare a quantity survey for a one-room, oak floor.
    - a. Filling
    - b. Shellacking
    - c. Varnishing
    - d. Waxing
    - e. Polishing
  - 3. Prepare a quantity survey for papering a living room from a set of plans.
  - 4. Prepare a quantity survey for a one-story residence for glazing. Assume that all windows will be glazed.

XI. Plumbing
- A. Units of instruction
  - 1. Rough plumbing
  - 2. Finished plumbing
- B. Laboratory
  - 1. From a set of plumbing plans and specifications, prepare a quantity survey of the rough plumbing.
  - 2. From a set of plumbing plans and specifications, prepare a quantity survey of the finished plumbing.

XII. Heating and Air Conditioning
- A. Units of instruction
  - 1. Kinds of heating systems
  - 2. Kinds of cooling systems
- B. Laboratory

  From a set of heating plans and specifications, prepare a quantity survey for a brick veneer residence (heating and cooling).

XIII. Electrical
- A. Units of instruction
  - 1. Wiring or "rough work"
  - 2. Fixtures or "finish work"
- B. Laboratory

  From a set of electrical plans and specifications, prepare an estimate for a brick residence for:
  - 1. Rough wiring
  - 2. Finished electrical work

Texts and References

BREED *and* HOSMER. *Elementary Surveying.*
PULVER. *Construction Estimates and Costs.*
WASS. *Building Construction Estimating.*

BUILDING MATERIALS AND CONSTRUCTION METHODS

Hours Per Week

Class, 3; Laboratory, 3

Description

This course is a broad survey of the materials used in construction, the buildings made from such materials, and the manner in which these materials and structures are utilized. The course will familiarize the student with the components of modern construction so that he can select the material best suited for the application, whether from the standpoint of durability and serviceability or from that of appearance, or both.

The course covers an extremely large subject area. The instructor, in preparing a day-by-day outline of items to consider, should therefore limit the discussion to the major aspects of each topic; more detailed information on each kind of material will be introduced in the laboratory work.

As far as possible, depending on class size, student projects in the laboratory should coincide with the background covered in the lecture periods. For example, when lectures deal with the characteristics and manufacture of brick, projects in the laboratory should be in brick construction, possibly small exercises in bricklaying, or typical problems related to this trade.

During the laboratory periods students should become familiar with building materials and the techniques of using them. The purpose of the laboratory is not to train craftsmen such as masons or carpenters but rather to enable students to gain insight into the architectural properties of the materials by working with the materials. Ideally, students should have some experience with the wide range of skills commonly found in construction work to gain the most from the laboratory work.

In addition, if possible, the class should make two or three visits during the semester to buildings under construction to acquire knowledge of how materials are utilized. Laboratory time may also be allotted to the viewing of filmstrips and motion pictures and to the reading of assigned articles in related magazines and journals.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Wood	8	12
II. Concrete	8	6
III. Masonry	8	6
IV. Metal	10	12
V. Finishes and Preservatives	6	9
VI. Other Materials	8	3
Total	48	48

I. Wood
- A. Units of instruction
  - 1. Types; characteristics; general use; classification
  - 2. Seasoning; moisture content
  - 3. Lumber manufacturing; defects; grading
  - 4. Structural use
  - 5. Exterior use and interior use
- B. Laboratory
  - 1. Construct a small project of wood requiring the cutting and truing of edges with hand tools.
  - 2. Cut the following typical wood joints:
    - a. Miter
    - b. Dado
    - c. Rabbet
    - d. Molding cuts (cope)
    - e. Spline
  - 3. Build typical carpentry framing details, such as:
    - a. Sill (use full-size 2 x 4's)
    - b. T-post stud wall intersection

        - c. Corner post
        - d. Rafter layouts

II. Concrete
  - A. Units of instruction
    1. Cement; aggregates
    2. Strength; durability; curing
    3. Mixing; placing; finishing
    4. Admixtures
    5. Structural use
    6. Exterior use
    7. Interior use
  - B. Laboratory
    1. Mix a 1:2:4 mix of concrete and cast a splash block.
    2. Mix and finish concrete specimens with the following finishes:
        - a. Steel trowel finish
        - b. Float finish
        - c. Broom finish
    3. Mix a terrazzo mix; pour, and finish it.

III. Masonry
  - A. Units of instruction
    1. Concrete block and brick
    2. Cast stone
    3. Natural stone
    4. Fired clay products
    5. Mortar
    6. Structural use
    7. Exterior use
    8. Interior use
  - B. Laboratory
    1. Prepare a batch of mortar for brickwork.
    2. Lay small wall of solid brick.
    3. Lay small brick cavity wall.
    4. Lay small wall of concrete block and brick veneer.

IV. Metal
  - A. Units of instruction
    1. Types; characteristics
    2. Manufacture of iron and steel
    3. General properties; use
    4. Alloys
    5. Structural use
    6. Exterior use
    7. Interior use
    8. Non-ferrous
  - B. Laboratory
    1. Arc-weld a typical steel connection.
    2. Make a typical riveted connection (use aluminum rivets).
    3. Bend reinforcing steel for a typical concrete form.
    4. Cut and thread typical steel pipe specimen.
    5. Cut and sweat a copper fitting and joint.
    6. Prepare a short length of gravel stop from galvanized iron, copper, or aluminum.

V. Finishes and Preservatives
  - A. Units of instruction
    1. Paint; shellac; varnish; coatings
    2. Wood treatments
    3. Metal treatments
    4. Vaporproofing; dampproofing; waterproofing
  - B. Laboratory
    1. Finish panel specimens of lead base paint, water base paint, enamel, shellac, or other finishes.
    2. Finish small project of wood with natural stain and proper finish.
    3. Antique a small painted project.
    4. Prepare and tape a gypsum board.
    5. Prepare and paint a galvanized iron specimen.
    6. Clean mortar from a small brick wall.

VI. Other Materials
  - A. Units of instruction
    1. Glass
    2. Plastics
    3. Bitumens
    4. Minerals (asbestos, lime, gypsum, mica, and the like)
    5. Paper
    6. Pulp products
  - B. Laboratory
    1. Cut and glaze a small light in a window.
    2. Make a small project from plastic.
    3. Prepare a small area of a 5-ply built-up roof with gravel stop.
    4. Prepare and apply a small area of acoustical plaster.

Texts and References

HORNBOSTEL. *Materials for Architecture: An Encyclopedic Guide.*

HUNTINGTON. *Building Construction: Materials and Types of Construction.*

MERRITT. *Building Construction Handbook.*

SWEET'S CATALOG SERVICE. *Architectural File.*

BUILDING SERVICE SYSTEMS (MECHANICAL AND ELECTRICAL)

Hours Per Week

Class, 3; Laboratory, 3

Description

This course introduces the study of the materials and equipment used in the mechanical and electrical service systems of buildings and also presents methods of designing certain parts of the various systems. It provides the student with information on how a modern building operates and, at the same time, enables him to make reasonable preliminary selections of the necessary equipment. The laboratory work parallels that of the classroom and in some instances may be an extension of it; for example, a design problem may be started in the classroom and completed in the laboratory.

The course is not intended to be a comprehensive design course. The example problems should illustrate general principles and should not become involved in minute design aspects. Each section in the outline can be presented independently, but the sequence of certain sections should be preserved. If it is desired to rearrange the order of presentation from that listed, Sections II, III, IV, V, and VI should be sequential.

A laboratory notebook should be required of each student in which he keeps the sketches, diagrams, and computations prepared in the laboratory. The instructor should at all times emphasize the relationship of the subject material to its use in buildings and should guard against treating each subject as a separate entity. Students should be encouraged to observe the service systems and equipment of buildings so that they may be better able to realize the intimate relationship of this equipment to the building as a whole.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Illumination for Buildings	6	6
II.	Comfort, Heat Loss, and Heat Gain	6	6
III.	Heating and Heating Systems	9	9
IV.	Air Conditioning and Climate Control	6	6
V.	Water Supply and Fire Protection	4	4
VI.	Drainage Systems, Plumbing, and Sewage Disposal	4	4
VII.	Electrical Sources, Materials, and Distribution	6	6
VIII.	Elevators and Escalators	4	4
IX.	Building Acoustics	3	3
	Total	48	48

I. Illumination for Buildings
  A. Units of instruction
    1. Definition of terms
    2. Characteristics of light and its measurement
    3. Lighting applied to building use
      a. Brightness
      b. Contrast
      c. Absorption
      d. Reflection
      e. Diffusion
      f. Transmission
      g. Glare
      h. Color
    4. Luminaires and their characteristics
    5. Sources of light
      a. Types
      b. Characteristics
      c. Operation
    6. Types of lighting systems
    7. Methods of illumination

8. Lighting system design
    a. Occupancy and use of space; economics of lighting
    b. Reflectance of surfaces
    c. Fixture selection and location
    d. Light output for luminaires
    e. High-lighting and accent-lighting
9. Flood-lighting
10. Emergency lighting

B. Laboratory
  1. Make sketches showing the effects of various luminaire types and placement on visual tasks at the working plane:
      a. Direct glare
      b. Reflected glare
      c. Definition of objects
  2. Design general lighting systems for rooms with different occupancy and use. Show fixture layout diagrams, and discuss different possible arrangements using both incandescent and fluorescent lamps.
  3. Assume typical costs of fixtures, lamps, and electrical energy. Consider lamp replacement, maintenance, and fixed charges; and prepare an annual cost comparison for different lighting systems designed for the same room.

II. Comfort, Heat Loss, and Heat Gain

A. Units of instruction
  1. Conditions affecting human comfort
      a. Relative humidity
      b. Air temperatures
      c. Surface temperatures
      d. Dust
      e. Air motion
      f. Odors
  2. Effective temperature
  3. Average comfort conditions
  4. Climate control
  5. Heat transmission through building materials
  6. Heat transmission through combined materials
  7. Heat losses from ground-supported concrete slabs
  8. Indoor and outdoor design temperatures
  9. Infiltration and ventilation
  10. Vapor barriers and insulations
  11. Sources of heat gain in buildings
  12. Thermal pressure effect of the sun
  13. Construction methods and building orientation applied to heat gain
  14. Methods of heat gain computations

B. Laboratory
  1. Calculate coefficients of heat transmission for various floor, wall, and roof constructions; compare calculated values with values from tables in the text or in references.
  2. Expand the computations begun in No. 1 to include the determination of heat losses from individual rooms; include infiltration or ventilation air.
  3. Determine the total heat loss for a small residence or commercial building.
  4. Establish the design conditions and estimate the heat gain for the same building used in No. 3 above.

III. Heating and Heating Systems

A. Units of instruction
  1. Methods of supplying heat to buildings
      a. Fuels
      b. Burners
      c. Methods of distribution
  2. Heating with warm air
      a. Systems using individual supply and return ducts
      b. Systems using crawl space as a plenum
      c. Systems with perimeter duct
      d. Controls and safety devices
      e. Sample computation of duct size and register location
  3. Heating with hot water
      a. One and two-pipe systems
      b. Systems with individual radiating devices
      c. Systems with radiant panels
      d. Controls and special equipment
      e. Sample design computation and pipe layout
  4. Heating with steam
      a. Relationship of pressure, temperature, and heat content of steam used for heating
      b. Air-vent systems
      c. One-pipe and two-pipe systems
      d. Gravity and mechanical systems
      e. Zoning for large buildings
      f. Sample pipe size determination
      g. Controls and special equipment
  5. Heating with electricity
      a. General concepts and suitability

    - b. Construction considerations to reduce heat loss
    - c. Types of electric heating equipment
    - d. Operating costs
    - e. Controls and special equipment
- B. Laboratory
  1. Prepare isometric diagrams showing the various methods of heat distribution.
  2. Prepare an isometric diagram showing plenum and duct assembly at a warm-air furnace.
  3. Prepare an isometric diagram showing piping and controls at a hot-water heating plant.
  4. Prepare a layout diagram of the supply and return ducts for a small warm-air heating system, and determine the size of ducts and fittings needed.
  5. Prepare an isometric layout of the piping needed for a small one- or two-pipe hot-water heating system, and determine the required sizes of supply and return pipe for the system.
  6. Prepare a layout diagram of the equipment used for a small electrical heating system. Assume the use of (a) baseboard units, and (b) radiant ceiling panels.

IV. Air Conditioning and Climate Control

- A. Units of instruction
  1. Refrigeration methods
  2. Definition of terms
  3. The psychrometric chart
  4. Humidity control
  5. Temperature control
  6. Air flow requirements
  7. Air conditioning equipment
  8. Air conditioning systems
  9. Distribution of conditioned air in buildings
  10. Design temperatures and conditions
- B. Laboratory
  1. Prepare a schematic diagram of the major sections of a central air conditioning plant using air distribution. Discuss the use of each section as it applies to summer and winter operation of the system.
  2. Prepare a schematic diagram of the major sections of a central air conditioning plant using chilled or heated water distribution. Discuss the flow of heat from the conditioned space to the atmosphere.
  3. Prepare a drawing of a basic psychrometric chart, and indicate the position of the major scales, showing the units of measurement for each.
  4. Select a point on a psychrometric chart to represent the initial conditions of an air sample. Construct a circle about this point, and state what must be done to the initial air sample so that it would have the properties indicated by points on this circle 30 degrees apart. Record the properties of the air sample for each point.
  5. Using the psychrometric chart, determine the temperature and moisture content of the air in the various sections of a central air conditioning unit for the following uses:
     - a. 100 percent air treated, summer conditions
     - b. 100 percent air treated, winter conditions
     - c. Some air recirculated, summer conditions

V. Water Supply and Fire Protection

- A. Units of instruction
  1. Sources of water
  2. Impurities in water
  3. Water treatment
  4. Public water systems
  5. Private water systems
  6. Pumps and pumping systems
  7. Types of pipes and fittings
  8. Considerations in piping installation
  9. Hot water requirements, storage, and heating
  10. Up-feed distribution systems
  11. Down-feed distribution systems
  12. Sample computations for pipe sizes
  13. Water sprinkler systems
  14. Standpipe systems
- B. Laboratory
  1. Prepare an isometric diagram of the cold and hot water piping for a small residence or commercial building, using an up-feed water supply system. Determine the necessary pipe sizes.
  2. Prepare an isometric diagram of the cold and hot water piping for a small commercial building, using a down-feed water distribution system. Determine the necessary pipe sizes

VI. Drainage Systems, Plumbing, and Sewage Disposal

- A. Units of instruction
  1. Components of a building drainage system
  2. Venting of building drainage systems
  3. Plumbing fixtures and drainage products
  4. Tests on plumbing and drainage systems
  5. Storm and rainwater drainage
  6. Sample computations for vent and drain pipe sizes
- B. Laboratory
  1. Prepare an isometric diagram showing the major drain and vent piping requirements for buildings in general
  2. Prepare an isometric diagram of the vent and drain piping for a residence. Show required pipe sizes
  3. Prepare an isometric diagram of the vent and drain piping for a small commercial building. Show required pipe sizes

VII. Electrical Sources, Materials, and Distribution

- A. Units of instruction
  1. Types of electrical service supplied to buildings
  2. Types of electrical service required by various devices
  3. Electrical distribution systems
  4. Electrical materials
     - a. Conductors
     - b. Switchboards
     - c. Panelboards
     - d. Fuses and circuit breakers
     - e. Raceways
  5. Electrical load determination
  6. Branch circuit and wire size determination
- B. Laboratory
  1. Prepare a layout of the electrical service for a medium-sized residence. Include lighting, laundry equipment, and yard lighting. Assume that a heat pump will be used with 20 kw additional resistance heat. Show switching arrangements for lights and receptacles
  2. Estimate the electrical load requirements in No. 1 and specify the switchboard and branch panel requirements
  3. Estimate the electrical load for a small commercial building. Locate the proper control and circuit boards and determine the feeder-wire sizes

VIII. Elevators and Escalators

- A. Units of instruction
  1. Types of elevators
  2. Speed controls
  3. Safety devices
  4. Scheduling and timing methods
  5. Costs of elevator systems
  6. Sample computations for elevator requirements in buildings
  7. Freight elevators
  8. Types of escalators installation
  9. Size and capacity of escalators
  10. Safety considerations
  11. Fire protection
- B. Laboratory
  1. Assume that a medium-sized office building (10 or 12 floors) has a population of from 1,200 to 1,500. Select elevators having various capacities and speeds; determine the number of elevators required, the passenger waiting time, and the cost of the different systems using each of the elevators selected
  2. Assume that a large office building (40 to 50 floors) has a population of from 4,000 to 5,000. Divide this building into three zones. Estimate times and percentage of the population of each zone to be moved, and recommend an elevator installation for this building

IX. Building Acoustics

- A. Units of instruction
  1. Properties of sound
  2. Reflection, absorption, and transmission of sound
  3. Hearing
  4. Reverberation
  5. Reduction of noise
  6. Acoustical properties of materials
  7. Room size, shape, and occupancy
- B. Laboratory
  1. Prepare plan and section views of several geometrically shaped rooms and show, in general, the sound propagation in each room. Consider the sound source in each room to be (a) at one end, (b) in the center, (c) near the ceiling.
  2. Specify floor, wall, and ceiling materials for each of the rooms in No. 1; determine the reverberation time for each room. Suggest changes in the type or location of

the materials used so as to produce a room having improved acoustic properties.

Texts and References

American Society of Heating, Refrigeration, and Air Conditioning Engineers. *ASHRAE Guide and Data Book.*

Clark *and* Viessman. *Water Supply and Pollution Control.*

Illuminating Engineering Society. *IES Lighting Handbook.*

Jennings. *Heating and Air Conditioning.*

Kinzey *and* Sharp. *Environmental Technologies in Architecture.*

Manufacturers' Catalogs and Publications.

McGuinness *and* others. *Mechanical and Electrical Equipment for Buildings.*

National Board of Fire Underwriters. *National Building Code.*

National Fire Protection Association. *National Electric Code.*

Rogers. *Thermal Design of Buildings.*

CONSTRUCTION PLANNING AND CONTROL

Hours Per Week

Class, 3

Description

This course is a general survey of the points that must be considered in a construction project. It covers the methods of determining the quantity and cost of the materials, labor, and equipment required, the scheduling of construction operations and an introduction to the Critical Path Method (CPM) of scheduling.

The instructor should rely heavily on catalogs, brochures, and descriptive literature of equipment manufacturers. For some sections of the course students will need handouts of typical charts or forms. If practicable, the class should visit several construction sites following its discussion of a particular type of equipment or phase of operation.

Major Divisions

	Class hours
I. Preliminary Considerations	3
II. Job Planning and Organization	3
III. Earthwork and Excavation	6
IV. Subsurface Work	6
V. Materials Handling and Placement	6
VI. Cost Estimating	6
VII. Construction Scheduling	6
VIII. Introduction to CPM Scheduling	6
IX. Job Inspection	6
Total	48

I. Preliminary Considerations
  A. Topography of the site
  B. Buildings near the site
  C. Base lines, reference marks, and levels
  D. Fuel, power, and water supplies
  E. Equipment planning and selection
  F. Local ordinances
  G. Bonds and insurance

II. Job Planning and Organization
  A. Field organization
  B. Office organization
  C. Local material and labor supply
  D. Coordination of sub-contractors
  E. Types of contracts
  F. Materials delivery and storage
  G. Safety during construction
  H. Public relations
  I. Job supervision
  J. Accounting procedures and forms

III. Earthwork and Excavation
  A. Types of earthwork equipment and costs
  B. Air-operated equipment
  C. Capacity and operation of tractor-type equipment
  D. Operations with clamshell, dragline, and hoe
  E. Operations with bulldozer and scraper
  F. Excavating-and-hauling units
  G. Recordkeeping on excavation
  H. Soil exploration and types of soil
  I. Compaction and stabilization of soil

Figure 14.—Planning and managing the sequence of building operations is critical and requires that technicians understand materials, design, construction methods, and modern building sequences. Good planning provides high-quality construction at reasonable costs.

IV. Subsurface Work
  A. Pumps and drainage equipment
  B. Cofferdams and caissons
  C. Piles and pile-driving
  D. Sheet piling
  E. Wellpoints
  F. Rock excavation
  G. Underpinning

V. Materials Handling and Placement
  A. Elevator and conveyor systems
  B. Hoisting equipment
  C. Steel frame erection and alignment
  D. Riveting, bolting, and welding equipment
  E. Concrete mixing and batching
  F. Transporting; placing; vibrating equipment
  G. Bending, placing, and supporting reinforcement

VI. Cost Estimating
  A. Preliminary estimates and unit costs
  B. Job analysis and work requirements
  C. Labor and equipment requirements
  D. Labor costs
  E. Equipment costs
  F. Materials and small tool costs
  G. Overhead and other costs

VII. Construction Scheduling
  A. General procedures
  B. Master schedule
  C. Progress reports and charts
  D. Labor schedules
  E. Equipment schedules
  F. Materials schedules
  G. Rescheduling
  H. Job communication

VIII. Introduction to CPM Scheduling
  A. General considerations and application
  B. Comparison with bar charts
  C. Arrow diagrams
  D. Network diagrams
  E. Elapsed time
  F. Float time
  G. Determining critical path
  H. Time related to cost
  I. Setting up a CPM network
  J. Using the CPM network

IX. Job Inspection
  A. Duties and responsibilities
  B. Authority
  C. Inspector's reports
  D. Equipment requirements
  E. Relations with labor and other contractors
  F. Limitations

Texts and References

Carson. *General Excavation Methods.*
Clough. *Construction Contracting.*
Deatherage. *Construction Scheduling and Control.*
Merritt. *Building Construction Handbook.*
O'Brien. *CPM in Construction Management.*
Oppenheimer. *Erecting Structural Steel.*
Stubbs. *Handbook of Heavy Construction.*

ELEMENTARY SURVEYING

Hours Per Week

Class, 1; Laboratory, 3

Description

The elementary course in surveying includes the fundamentals of plane surveying and the use of surveying equipment. It emphasizes architecture-related aspects of surveying and the development of skills in using surveying field information. The measuring of distance, theory and practice of leveling, angles and bearing principles and use of the transit, stadia, contour and topographic surveying, and construction surveying problems are studied in coordinated class and laboratory assignments.

The instructor may need to change the sequence of the subject matter as shown in the course outline. In the geographical locations where extreme or inclement weather conditions occur early in the semester, the indoor work like computations, plotting, office details, lectures, and demonstrations may need to be given before any field work can be done. However, surveying is an outside activity, and effort should be made to do field work whenever possible.

The terrain selected for field problems should be rugged enough to introduce normal complexities but not so rugged as to require excessive time in execution. The area used for surveys should be one in which the stakes can be left in place until the survey is completed, after which each survey group should remove the stakes and other markings.

Laboratory-field survey periods will generally be 3 hours, once a week, with a 1-hour period for class lectures and problem-solving; however, this arrangement may be altered to fit the circumstances.

Field work should approximate industrial practice, with considerable emphasis on the degrees of precision required in good surveying practice. Field notes should be reduced to a convenient form for the plotting or calculation of distances and volumes. Field notebooks should be kept according to good professional practice, and errors of closure should be recorded. If a survey group exceeds the permissible error on a field problem, it should repeat the problem outside the regular class hours. Students should become proficient in the duties of each member of a survey group by rotating from position to position. They should be required to read and study the daily assignments as homework. The students should also have some computations to finish outside of class time after starting them in the classroom.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Introduction to Surveying Instruments	1	3
II. Leveling	3	9
III. Transit and Tape (and Stadia)	3	9
IV. Contour Surveys and Topographic Mapping	5	15
V. Construction Surveys	4	12
Total	16	48

I. Introduction to Surveying Instruments
  A. Units of instruction
    1. Class procedure and objectives
    2. The level instrument
      a. Hand level
      b. Dumpy level
    3. The level rod
    4. The tape
      a. Steel tape
      b. Metallic tape
      c. The plumb bob

    - d. Steel pins
    - e. Range poles
  - 5. The transit
- B. Laboratory
  - 1. Practice setting up the level.
  - 2. Practice reading the level rod.
  - 3. Practice taping:
    - a. On level ground
    - b. On sloping ground

II. Leveling

- A. Units of instruction
  - 1. General principles of leveling
  - 2. The dumpy level
    - a. Telescope
      - (1) Eyepiece
      - (2) Cross-hairs
      - (3) Parallax
    - b. Bubble-tube
    - c. Tangent and clamp screws
    - d. Leveling screws and foot-plate
    - e. Tripod
  - 3. Level rods
  - 4. Theory of leveling
    - a. Bench mark
    - b. Turning point
    - c. Backsight
    - d. Height of instrument
    - e. Foresight
  - 5. Field procedure
    - a. Makeup of group members
    - b. Note-keeping
    - c. Signals
  - 6. Sources of error in leveling
- B. Laboratory
  - 1. Run a short bench mark level circuit and record in notebook.
  - 2. Run a longer bench mark level circuit.
  - 3. Run another bench mark level circuit; level circuit not checked within allowable accuracy should be repeated.

III. Transit and Tape (and Stadia)

- A. Units of instruction
  - 1. Description of transit
    - a. Use of instrument
    - b. Care of instrument
  - 2. Definition of terms as applied to transit work
    - a. Orientation
    - b. Backsight and foresight
    - c. Normal and direct position
    - d. Inverted position
    - e. Reversal of instrument
    - f. Horizontal and vertical motion
    - g. Upper and lower motions
  - 3. Vernier and its use
    - a. Linear and circular scales
    - b. Vernier readings
  - 4. Setting up transit for use
    - a. Instrument leveled
    - b. Instrument centered over fixed point
  - 5. Measuring horizontal angles
  - 6. Prolonging a straight line
  - 7. Measuring vertical angles
  - 8. Measuring angles by repetition
  - 9. Transit-stadia surveying theory
    - a. Principle
    - b. Stadia constants
    - c. Interval factor
    - d. Horizontal sights
    - e. Inclined sights
    - f. Reduction of stadia notes
  - 10. Sources of error
    - a. Imperfect adjustment of transit
    - b. Reading the vernier
    - c. Sighting and parallax
    - d. Setting over point
    - e. Soft ground
    - f. Reading stadia rod; rod not plumb; length of rod
- B. Laboratory
  - 1. Practice setting up transit and reading angles.
  - 2. Practice measuring distances using transit to prolong a line.
  - 3. Perform a deflection angle traverse, checking distances by stadia.

IV. Contour Surveys and Topographic Mapping

- A. Units of instruction
  - 1. Characteristics of contours and contour lines
  - 2. Systems of contour points
  - 3. Contour line construction
  - 4. Contour map problems
  - 5. Field methods of procuring information for contours
  - 6. Horizontal control for topographic surveying
    - a. Traverse
    - b. Triangulation
  - 7. Vertical control
  - 8. Accuracy map
  - 9. Scale of map
  - 10. Contour interval

B. Laboratory
   1. Prepare a contour map from a pre-assembled set of field notes.
   2. Perform a transit-stadia traverse and determine the contours for an area.
   3. Locate and plot contours and topography for an area from the traverse.

V. Construction Surveys
  A. Units of instruction
    1. Field layout of structures
      a. Set temporary stakes for corners of structure
      b. Measure diagonals and check
      c. Set batter boards at determined grade
      d. Determine alinement across batter boards
    2. Field staking for earthwork
      a. Original grade
      b. Finished grade
    3. Pipeline layout
    4. Setting screed stakes for concrete work
  B. Laboratory
    1. Perform field layouts for non-rectangular buildings.
    2. Set finished grade stakes in contour map traverse area.

Texts and References

BOUCHARD. *Surveying.*

DAVIS *and* FOOTE. *Surveying: Theory and Practice.*

KISSAM. *Surveying.*

LAURILIA. *Electronic Surveying and Mapping.*

RAYNER *and* SCHMIDT. *Elementary Surveying.*

SMIRNOFF. *Measurements for Engineering and Other Surveys.*

U.S. DEPARTMENT OF COMMERCE, COAST AND GEODETIC SURVEY. *Sines, Cosines, and Tangents; Ten Decimal Places—0 Degrees to 6 Degrees—Lambert Projections.*

———. *The State Coordinate Systems.*

———. *Topographic Sheets (of school area).*

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, OFFICE OF EDUCATION. *Civil Technology, Highway and Structural Options, A Suggested 2-Year Post High School Curriculum.*

U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT. *Restoration of Lost or Obliterated Corners and Subdivision of Sections.*

Visual and Training Aids

U.S. Department of Transportation, Bureau of Public Roads, Washington, D.C. 20553.

Safety in Highway Surveying. 16 mm., 25 min., color, sound.

Mathematics and Science Courses

TECHNICAL MATHEMATICS I

Hours Per Week

Class, 5

Description

The course in algebra and trigonometry deals with principles and applications in the technology. The choice of topics and the order in which they are presented integrate mathematics with the technical courses in the curriculum. The real number system is developed as an extension of natural numbers; various systems of numbers are introduced.

A study of the slide rule is presented, and a few minutes each day for several weeks may be devoted to the use of the slide rule, significant figures, and scientific notation, instead of concentrating on each topic for several periods of continuous study. Fundamental and advanced algebraic operations, the rectangular coordinate system, and the analytic geometry of the straight line are studied. Inequalities are considered, along with equations and identities. Determinants are introduced as a means of solving systems of equations. Exponential and trigonometric relationships are explored. Fundamental trigonometric concepts and operations are studied, with emphasis on the right triangle and graphic representation of the functions.

The various topics should be introduced so as to emphasize the basic principles involved and the important role each plays in architecture and building construction technology. Practical problems, many from the technical field, should be assigned to reinforce understanding of the topics studied.

Since engineering technology is continually changing, periodic reviews of course content and textbooks are in order. In special applications, such as shear and moment diagrams or centroids, supplementary materials (handouts) and problems may prove beneficial. The students are expected to supplement classroom work with adequate problem-solving and study for each hour spent in class.

Major Divisions

	Class hours
I. Factoring and Fractions	4
II. Algebraic Functions	23
III. Exponents and Radicals	7
IV. Logarithms	5
V. Inequalities	4
VI. Linear Variation	2
VII. Theory of Equations	4
VIII. Progressions	3
IX. Introduction to Trigonometry	10
X. Slide Rule	6
XI. Oblique Triangles	5
XII. Vectors	7
Total	80

I. Factoring and Fractions
  - A. Review of factoring techniques
  - B. Operations with fractions
  - C. Compound fractions

II. Algebraic Functions
  - A. Linear equations
  - B. Quadratic equations
  - C. Systems of equations
  - D. Graphical solutions
  - E. Determinants
  - F. Logarithmic equations
  - G. Exponential equations
  - H. Worded problems

III. Exponents and Radicals
  - A. Laws and exponents
  - B. Positive and negative exponents

C. Fractional exponents
D. Properties of radicals
E. Operations with radicals

IV. Logarithms
A. Definition and properties of logarithms
B. Operations with logarithms
C. Use of log tables
D. Relationship of base 10 and base "e" logs

V. Inequalities
A. Linear inequalities
B. Quadratic inequalities
C. Graphical solutions
D. Absolute inequalities

VI. Linear Variation
A. Direct and inverse variation
B. Joint variation

VII. Theory of Equations
A. Factor theorem
B. Remainder theorem
C. Synthetic division

VIII. Progressions
A. Arithmetic progressions
B. Geometric progressions
C. Formulas for sum of "n" terms

IX. Introduction to Trigonometry
A. Definition of trigonometric functions
B. Values of functions of 30–45–60 degree terminal angles
C. Use of trig tables and interpolation thereof
D. Significant figures
E. Solution of right triangles
F. Radian measure
G. Angular motion and arc length

X. Slide Rule
A. Multiplication and division
B. Roots and powers
C. Trigonometric scales
D. Solution of right triangles
E. Introduction to log-log scales

XI. Oblique Triangles
A. Law of sines
B. Law of cosines
C. Law of tangents and areas
D. Slide rule solutions

XII. Vectors
A. Definition of scalar and vector quantities
B. Operations with vectors
C. Applications

Text and References

ALLENDOEFER *and* OAKLEY. *Fundamentals of Freshman Mathematics.*

ELLIOTT, MILES, *and* REYNOLDS. *Mathematics: Advanced Course.*

JUSZLI *and* RODGERS. *Elementary Technical Mathematics.*

KRUGLAK *and* MOORE. *Basic Mathematics for the Physical Sciences.*

RICE *and* KNIGHT. *Technical Mathematics.*

TECHNICAL MATHEMATICS II

Hours Per Week

Class, 4

Description

This course continues Mathematics I. Advanced algebraic and trigonometric topics, including solution of oblique triangles, complex numbers as vectors, trigonometric identities and equations, are studied in depth. The fundamental principles of analytical geometry and differential and integral calculus are introduced. Topics included are: graphing techniques, geometric and algebraic interpretation of the derivative, differentials, rate of change, the integral, and basic integration techniques. Application of these concepts to practical situations are studied, with emphasis on applying the principles studied to architecture and building construction technology.

Again, the ever-changing nature of engineering technology requires that the instructor review course content and textbooks regularly. In special applications, such as shear and moment diagrams or centroids, supplementary materials (handouts) and problems may prove beneficial. The students are expected to supplement classroom work with problem-solving and study at home.

Major Divisions

	Class hours
I. Complex Numbers	5
II. Trigonometric Identities	6
III. Trigonometric Equations	3
IV. Inverse Trigonometric Equations	2
V. Graphs of Trigonometric Functions	4
VI. Plane Analytic Geometry	8
VII. Differential Calculus	20
VIII. Integral Calculus	16
Total	64

I. Complex Numbers
  A. Algebraic form
  B. Polar and exponential form
  C. Operations with complex numbers
  D. "J" operator applications

II. Trigonometric Identities
  A. Additional definitions
  B. Reduction formulas
  C. Negative angles
  D. Half and double angles
  E. Sum and difference angles
  F. Factoring formulas
  G. Identities

III. Trigonometric Equations
  A. Linear
  B. Quadratic

IV. Inverse Trigonometic Functions
  A. Definition of inverse functions
  B. Principal valued functions
  C. Identities

V. Graphs of Trigonometric Functions
  A. Amplitude; periodicity
  B. Phase shift; frequency
  C. Addition of ordinates

VI. Plane Analytic Geometry
  A. Straight line, equation, distance
  B. Slope, parallel, and perpendicular lines
  C. Angle between lines
  D. Circles—standard forms
  E. Conic sections—ellipse, parabola, hyperbola, standard forms

VII. Differential Calculus
  A. Limits
  B. Definition of the derivative and four-step method
  C. Rate of change
  D. Continuity
  E. Derivatives of powers
  F. Velocity and acceleration
  G. Maxima and minima; critical points
  H. Differentiation by formula
  I. Differentiation of implicit functions

- J. Chain rule
- K. Related rates

VIII. Integral Calculus
- A. Integration as antidifferentiation
- B. Definite integrals
- C. Calculation of area
- D. Fundamental theorem
- E. Centroids
- F. Moment of inertia
- G. Fluid pressure and work

Texts and References

ANDREE. *Introduction to Calculus with Analytic Geometry.*

ELLIOTT, MILES, *and* REYNOLDS. *Mathematics: Advanced Course.*

FORD *and* FORD. *Calculus.*

JUSZLI. *Analytic Geometry and Calculus.*

KRUGLAK *and* MOORE. *Basic Mathematics for the Physical Sciences.*

RICE *and* KNIGHT. *Technical Mathematics.*

WASHINGTON. *Basic Technical Mathematics with Calculus.*

APPLIED PHYSICS (MECHANICS AND HEAT)

Hours Per Week

Class, 3; Laboratory, 3

Description

This course covers the basic principles of mechanics as applied to solid bodies and to fluids and the basic principles of heat. Its objectives extend beyond its immediate purpose of helping the student understand the basic principles of mechanics and heat. The emphasis in both laboratory and lecture upon the scientific method is not apparent in the outline but is of crucial importance.

The subject matter taught in physics and mathematics should be closely coordinated to produce an optimum opportunity for the student to master both subjects. Emphasis should be placed upon material from the mathematics course, on the use of the slide rule in computation of data in the laboratory, and on the solving of problems.

It is suggested that the course consist of one hour of demonstration-lecture, 2 hours of recitation, and a 3-hour laboratory period each week.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Fundamental Quantities	3	3
II. Vectors	3	3
III. Statics	6	3
IV. Linear Motion	3	3
V. Force and Motion	3	3
VI. Work, Energy, and Momentum	5	6
VII. Uniform Circular Motion and Gravitation	2	3
VIII. Rotational Motion	3	3
IX. Elasticity	2	3
X. Simple Harmonic Motion	2	3
XI. Fluids	4	3
XII. Temperature and Heat	4	6
XIII. Thermal Properties of Matter	3	6
XIV. Heat transfer	2	
XV. Thermodynamics	3	
Total	48	48

I. Fundamental Quantities
- A. Units of instruction
  - 1. Standards of length, mass, and time
  - 2. MKS and FPS units
  - 3. Conversion of units
- B. Laboratory
  - 1. Study the use of vernier and micrometer devices.
  - 2. Conduct experiments to demonstrate significant figures; accuracy; precision.
  - 3. Study the theory of errors as applied to laboratory observations.

II. Vectors
- A. Units of instruction
  - 1. Vectors *vs.* scalars
  - 2. Analytical addition of vectors
  - 3. Graphical
  - 4. Resolution of vectors
- B. Laboratory
  - 1. Demonstrate principles of the force table.
  - 2. Use force table to determine resultant and equilibrant of given sets of forces.
  - 3. Use graphical method to solve for resultant and equilibrant of given sets of forces.

III. Statics
- A. Units of instruction
  - 1. Newton's first and third laws
  - 2. Free-body diagrams
  - 3. First condition of equilibrium
  - 4. Second condition of equilibrium
- B. Laboratory
  - 1. Demonstrate principles of apparatus (beam, derrick, etc.) used in studying equilibrium.

2. Confirm the first and second conditions of equilibrium.

IV. Linear Motion
A. Units of instruction
1. Types of motion
2. Velocity and acceleration in rectilinear motion
3. Projection motion
B. Laboratory
1. Demonstrate and explain principles of operation of free-fall apparatus.
2. Use data to confirm equations for uniformly accelerated rectilinear motion.
3. Calculate the local value of "g," the acceleration due to gravity.

V. Force and Motion
A. Units of instruction
Newton's second law; inertia, mass, and weight
B. Laboratory
1. Demonstrate and explain use of Newton's second law apparatus.
2. Confirm Newton's second law.

VI. Work, Energy, and Momentum
A. Units of instruction
1. Work
2. Power
3. Kinetic and potential energy
4. Conservation of energy
5. Momentum
6. Collisions
7. Simple machines
8. Friction
B. Laboratory
1. Use level and inclined planes to determine static and kinetic coefficients of friction.
2. Determine the ideal and actual mechanical advantages and the efficiency of several simple machines.

VII. Uniform Circular Motion and Gravitation
A. Units of instruction
1. Uniform circular motion
2. Centripetal force
3. Centripetal acceleration
4. Newton's law of universal gravitation
5. Variation of "g" and weight
B. Laboratory
1. Demonstrate uniform circular motion apparatus.
2. Calculate centripetal acceleration of and centripetal force on a body in uniform circular motion.

VIII. Rotational Motion
A. Units of instruction
1. Angular velocity
2. Angular acceleration
3. The equations of angular motion
4. Kinetic energy of rotation
5. Moment of inertia
6. Combined energy of translation and energy of rotation
7. Newton's laws for rotational motion
8. Angular momentum; gyroscopes
B. Laboratory
1. Demonstrate apparatus used to determine rotational moment of inertia.
2. Determine the moment of inertia of an object from known torque and observed angular acceleration. Compare this to the theoretically calculated value.

IX. Elasticity
A. Units of instruction
1. Elasticity
2. Hooke's law
3. Stress and strain
4. Young's modulus
5. Stiffness and strength of beams
6. Bulk modulus
7. Shear modulus
B. Laboratory
1. Demonstrate Young's modulus apparatus.
2. Verify Hooke's law.
3. Determine Young's modulus for an unknown material.

X. Simple Harmonic Motion
A. Units of instruction
1. Simple harmonic motion; circle of reference
2. Period, velocity, and acceleration in simple harmonic motion
3. Force and energy in simple harmonic motion
4. The simple pendulum
B. Laboratory
1. Demonstrate the Jolly balance.
2. Use the Jolly balance with various masses or pan. Plot and interpret a graph of period squared versus mass.
3. Use a simple pendulum to determine the local value of "g", the acceleration due to gravity.

XI. Fluids
   A. Units of instruction
      1. Pressure
      2. Pascal's principle; the hydraulic press
      3. Pressure and depth
      4. Archimedes' principle; floating bodies
      5. Density and specific gravity
      6. Fluid flow
      7. Bernoulli's equation
   B. Laboratory
      1. Demonstrate the use of Archimedes' principle in determining the density of an irregularly shaped object.
      2. Determine the density and specific gravity of several unknown solids and liquids.

XII. Temperature and Heat
   A. Units of Instruction
      1. Temperature; temperature scales; thermometers
      2. Heat as energy; units
      3. Specific heat; calorimetry
      4. Change of state
      5. Mechanical equivalent of heat
   B. Laboratory
      1. Demonstrate the calorimeter and explain principles involved in its use.
      2. Determine the specific heat of an unknown substance by the method of mixtures.
      3. Determine the heat of fusion and the heat of vaporization of water.

XIII. Thermal Properties of Matter
   A. Units of Instruction
      1. Thermal expansion
      2. Area and volume expansion
      3. Gas laws
      4. Kinetic theory
   B. Laboratory
      1. Determine linear expansion apparatus
      2. Determine the coefficient of linear expansion of an unknown material.
      3. Demonstrate the Boyle's and Charles' law apparatus.
      4. Verify Boyle's and Charles' laws.

XIV. Heat Transfer
   A. Units of instruction
      1. Conduction
      2. Convection
      3. Radiation
   B. Laboratory (none)

XV. Thermodynamics
   A. Units of instruction
      1. First law of thermodynamics
      2. Second law of thermodynamics
      3. Isothermal and adiabatic processes
      4. Heat engines
      5. The refrigerator
   B. Laboratory (none)

Texts and References

Beiser. *Modern Technical Physics.*
Joseph, Pomeranz, Prince, *and* Sacher. *Physics for Engineering Technology.*
Orear. *Fundamental Physics.*
Richards, Sears, Wehr, *and* Zemansky. *Modern College Physics.*
Sears *and* Zemansky. *College Physics, Part II.*
Semat. *Fundamentals of Physics.*
Smith *and* Cooper. *Elements of Physics.*
White. *Modern College Physics.*

Visual Aids (Films are black and white, unless color is noted)

American Chemical Society, 1155 16th Street NW., Washington, D.C. 20036.
   Vibrations of Molecules (Linus Pauling and Richard M. Badger: Collaborators), 16 mm., 12 min., color, sound.
Encyclopedia Britannica Films, Inc., 1150 Wilmette Avenue, Wilmette, Ill. 60091.
   Galileo's Laws of Falling Bodies, 16 mm., 6 min., sound.
   Gas Laws and Their Application, 16 mm., 13 min., sound.
   Heat; Its Nature and Transfer, 16 mm., 11 min., sound.
   Laws of Motion, 16 mm., 13 min., sound.
   Simple Machines, 16 mm., 11 min., sound.
   Thermodynamics, 16 mm., 11 min., sound.
McGraw-Hill Book Co., 330 West 42nd Street, New York, N.Y. 10036.
   Carnot Cycle (Kelvin Temperature Scale), 16 mm., 8 min., sound.
   Diesel Engine, 16 mm., 8 min., sound.
   Gasoline Engine, 16 mm., 8 min., sound.
   Uniform Circular Motion, 16 mm., 8 min., sound.
   Gas Pressure and Molecular Collisions (J. Arthur Campell: Collaborator), 16 mm., 21 min., sound.
   Ionization Energy (Bruce H. Mahan: Collaborator), 16 mm., 22 min., color, sound.
Norwood Films, 926 New Jersey Avenue NW., Washington, D.C. 20001.
   Basic Hydraulics, 16 mm., 9 min., sound.
   Electron: An Introduction, 16 mm., 16 min., sound.
   Principles of Dry Friction, 16 mm., 17 min., sound.
   Principles of Moments, 16 mm., 23 min., sound.
   Principles of Refrigeration, 16 mm., 20 min., sound.
   Verniers, 16 mm., 19 min., sound.

APPLIED PHYSICS (ELECTRICITY, LIGHT, AND SOUND)

Hours Per Week

Class, 3; Laboratory, 3

Description

The introductory course in sound, light, and electrical circuitry and equipment, emphasizes physical principles as they are applied in architectural and building construction. Special emphasis is placed upon the study of electricity because of the increasing importance of electrical and electronic applications and controls in buildings. An understanding of light is necessary to architectural and building construction technicians.

The course should consist of 1 hour of demonstration-lecture, 2 hours of recitation, and a 3-hour laboratory period each week. Emphasis should be placed on the solving of problems.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Sound	6	3
II. Light and Illumination	3	3
III. Reflection and Refraction	6	3
IV. Lenses and Optical Instruments	4	3
V. Interference and Diffraction	1	3
VI. Static Electricity	8	3
VII. Electric Current	7	18
VIII. Magnetism	3	3
IX. Induced Electromotive Forces	4	3
X. Alternating Currents and Electronics	6	6
Total	48	48

I. Sound
  A. Units of instruction
    1. Wave motion
    2. Sound waves
    3. Sound sources
  B. Laboratory
    1. Demonstrate the use of a resonance tube and Kundt's tube apparatus.
    2. Use the resonance tube to calculate the velocity of sound in air
    3. Use the Kundt's tube apparatus to calculate the velocity of sound in air

II. Light and Illumination
  A. Units of instruction
    1. Nature of light; rectilinear propagation
    2. Standard sources, luminous flux, illuminance, and the photometer
    3. Velocity of light; wave length and frequency
  B. Laboratory
    1. Demonstrate and explain principles of operation of the photometer and the foot-candle meter.
    2. Use the photometer to measure the luminous intensity of an unknown lamp.
    3. Use the foot-candle meter to measure the illumination produced by an electric lamp as a function of distance and orientation.

III. Reflection and Refraction
  A. Units of instruction
    1. Reflection
    2. The plane mirror
    3. The spherical mirror, concave and convex
    4. The sign convention and standard rays for mirrors
    5. Spherical aberration and the parabolic mirror
    6. Refraction
    7. Indices of refraction; critical angles
    8. Atmospheric refraction; mirages
    9. Dispersion; the rainbow
  B. Laboratory
    1. Demonstrate use of the optical disk.
    2. Use the optical disk to verify laws of reflection and refraction. Sketches should show aberration and dispersion.

IV. Lenses and Optical Instruments
  A. Units of instruction
    1. Simple lenses

   2. Standard rays for lenses
   3. The single lens; the lens equation
   4. Combinations of lenses
   5. The lens maker's equation
   6. Lens defects
   7. The eye
   8. The camera
   9. The telescope
   10. The microscope
  B. Laboratory
   1. Demonstrate use of the optical bench.
   2. Determine the focal length of single and combinations of lenses.
   3. Set up lenses to illustrate principles of microscope and simple telescopes.

V. Interference and Diffraction
  A. Units of instruction
   1. Double-slit interference
   2. The interferometer
   3. Diffraction
   4. The diffraction grating
  B. Laboratory
   1. Demonstrate use of diffraction grating
   2. Use grating to determine wave length of light.

VI. Static Electricity
  A. Units of instruction
   1. Electric charges; Coulomb's law
   2. The electric field; lines of force
   3. Electrostatic induction; the electroscope
   4. Potential and potential difference; equipotential surfaces
   5. Capacitors and dielectrics
   6. Energy stored in a capacitor
   7. Capacitors in parallel and in series
  B. Laboratory
   1. Demonstrate and explain operation of the capacitance bridge.
   2. Use capacitance bridge to determine the value of an unknown capacitor.
   3. Verify the equations for capacitors in series and in parallel.

VII. Electric Current
  A. Units of instruction
   1. The electric current; Ohm's law
   2. Joule's law of heating
   3. Resistivity
   4. Temperature coefficient of resistance
   5. Resistors in series and in parallel
   6. Electromotive force
   7. The electric circuit
   8. Kirchoff's laws
   9. Wheatstone's bridge and the potentiometer
   10. Electrochemical and thermoelectric effects
  B. Laboratory
   1. Demonstrate and explain methods of connecting circuit components.
   2. Verify Ohm's law. Verify equations for equivalent resistances of resistors connected in series and in parallel.
   3. Verify Joule's law for heating effect of an electric current.
   4. Measure resistance by the voltmeter and ammeter method.
   5. Demonstrate and explain the simple slidewire form of Wheatstone's bridge.
   6. Measure resistance using Wheatstone's bridge.
   7. Demonstrate and explain the simple slidewire form of the potentiometer.
   8. Measure emf using the potentiometer.
   9. Run calibration curves on a thermocouple.

VIII. Magnetism
  A. Units of instruction
   1. Magnetic field due to a current
   2. Magnetic forces on a moving charge
   3. Galvanometer, ammeter, and voltmeter
   4. Coils, solenoids, and other current configurations
   5. Permanent magnets
   6. Coulomb's law for magnetic poles
   7. Permeability and the magnetizing field
   8. Hysteresis
  B. Laboratory
   1. Discuss the use of ammeter shunts and voltmeter multipliers.
   2. Convert a given galvanometer to an ammeter and to a voltmeter of desired characteristics.

IX. Induced Electromotive Forces
  A. Units of instruction
   1. Magnetic flux: the Weber
   2. Faraday's law of electromagnetic induction
   3. Lenz's law
   4. Motional electromotive force
   5. Mutual inductance
   6. The transformer; the induction coil
   7. Self-inductance
   8. The emf in a rotating loop
   9. Collecting rings and commutators

  - 10. The generator
  - 11. The motor
- B. Laboratory
  - 1. Demonstrate induction apparatus.
  - 2. Determine the factors upon which the value of the induced emf depends.

X. Alternating Currents and Electronics

- A. Units of instruction
  - 1. The alternating emf, effective value
  - 2. Inductive reactance
  - 3. Capacitive reactance
  - 4. The AC circuit, impedance, resonance
  - 5. Thermionic emission
  - 6. The diode; the diode as a rectifier
  - 7. The triode; the triode as an amplifier
  - 8. The triode oscillator, the transmitter, and the receiver
  - 9. The oscilloscope; TV; radar
- B. Laboratory
  - 1. Demonstrate electrical-resonance apparatus. Discuss functions of the various components of an electron tube.
  - 2. Construct and interpret a phase diagram for a series AC circuit.
  - 3. Plot the characteristic curves for a triode.

Texts and References

The same as the references for Applied Physics (Mechanics and Heat)

Visual Aids (Films are black and white)

Encyclopedia Britannica Films, Inc., Wilmette, Ill. 60091.
Series and Parallel Circuits, 16 mm., 11 min., sound.
What is Electricity?, 16 mm., 13 min., sound.
Electro-Dynamics, 16 mm., 11 min., sound.
Magnetism, 16 mm., 16 min., sound.

Norwood Films, 926 New Jersey Avenue NW., Washington, D.C. 20001.
Capacitance, 16 mm., 31 min., sound.
Diodes: Principles and Applications, 16 mm., 17 min., sound.
Ohm's Law, 16 mm., 19 min., sound.
RCL: Resistance Capacitance, 16 mm., 34 min., sound.
Voltaic Cell, Dry Cell, and Storage Battery, 16 mm., 18 min., sound.

U.S. Atomic Energy Commission (Obtainable from any regional office)
The International Atom, 16 mm., 27 min., sound.

STATICS AND STRENGTH OF MATERIALS

Hours Per Week

Class, 3; Laboratory, 3

Description

This course introduces the student to the basic principles of statics and structural mechanics and to the effects of loads and loading on building elements and frames. Methods are developed for determining preliminary sizes of certain key building elements, knowledge of which is essential to proper building layout and development. The material presented makes it possible for the student to understand the interaction of the various elements used in a framing system.

The laboratory consists of computational work and using the testing machine. Students should be required to keep a laboratory notebook containing sample computations for and descriptions of all tests performed. The problems specified for laboratory use are general and should be adapted to fit the class discussion. To save time, the instructor may wish to issue drawings and diagrams for laboratory use instead of having the students prepare them.

Major Divisions

	Hours	
	Class	*Laboratory*
I. Materials, Stress, and Deformation	4	3
II. Properties of Sections	5	6
III. Gravity Loads on Building Frames	4	3
IV. Shear and Bending in Beams—Statically Determinate	6	6
V. Stresses in Beams and Beam Sizes	6	6
VI. Beam Deflection	6	6
VII. Shear and Bending in Beams—Statically Indeterminate	5	6
VIII. Stresses in Columns and Column Sizes	6	6
IX. Riveted and Welded Connections	6	6
Total	48	48

I. Materials, Stress and Deformation
  A. Units of instruction
    1. Properties of construction materials
    2. Types of stresses in members
    3. Ultimate and allowable stresses
    4. Direct stress; deformation
    5. Elasticity and Hooke's law
    6. Stress-strain diagram
  B. Laboratory
    1. Discuss the operation and use of a testing machine.
    2. Demonstrate axial loading in tension and compression (direct stress).
    3. Demonstrate Hooke's law, using mild steel bars.
    4. Determine, by test, the modulus of elasticity of steel.
    5. Prepare a stress-strain diagram for mild steel, and discuss the critical points thereon. (Test to failure in tension.)

II. Properties of Sections
  A. Units of instruction
    1. Centroids and moments of area
    2. First moment of area
    3. Second moment of area
    4. Parallel axis theorem
    5. Radius of gyration
    6. Section modulus
  B. Laboratory
    1. Compute the location of the centroid for various geometrical shapes. Check results

   by comparing with values obtained from tables.
2. Determine the location of the centroid of various irregularly shaped areas.
3. Compute moment of inertia, radius of gyration, and section modulus of composite shapes. Include some standard steel sections, and check values with those given in tables.

III. Gravity Loads on Building Frames

- A. Units of instruction
  1. Basic framework types
  2. Live loads
  3. Dead loads
  4. Floor and roof loads
  5. Wall and partition loads
  6. Equipment loads
  7. Application of loads to framing members
  8. Uniformly distributed loads
  9. Concentrated loads
  10. Loading diagrams
- B. Laboratory
  1. Prepare a framing plan of a small building, using "beam-and-girder" framing. Identify each member, and dimension the span lengths. (Some members should be unsymmetrically loaded.)
  2. Assume a floor and exterior wall construction and occupancy; determine the general surface loads to be applied to the framing system.
  3. Construct a loading diagram for each beam, girder, and column shown on the framing plan. (Neglect the weight of the members.)

IV. Shear and Bending in Beams—Statically Determinate

- A. Units of instruction
  1. Reactions and shear
  2. Symmetrical loading
  3. Unsymmetrical loading
  4. Shear diagrams
  5. Moment diagrams
  6. Cantilever and overhanging members
  7. Critical sections for moment and shear
- B. Laboratory
  1. Construct shear and moment diagrams for the beams and girders of the framing plan prepared for the previous lab. (Part III.)
  2. Prepare a framing plan and select loads and spans suitable for use with timber construction.
  3. Construct loading diagrams, and compute values of maximum moments and shears for the members of the timber-framed building.

V. Stresses in Beams and Beam Sizes

- A. Units of instruction
  1. Tensile and compressive stresses
  2. Shear stresses
  3. Allowable loads on beams
  4. Timber beam selection
  5. Steel beam selection
  6. Beams without proper lateral support
- B. Laboratory
  1. Select standard rolled steel sections suitable for the beams and girders indicated on the framing plan prepared in Part III (steel frame). Use lateral support conditions as provided by the framing. (Include weight of the members.)
  2. Specify a depth restriction for certain members and determine a suitable builtup section.
  3. Specify conditions so that certain members do not have proper lateral support and select sections suitable under these conditions.
  4. Select solid or builtup timber sections suitable for the beams and girders indicated on the framing plan prepared in Part IV (timber frame). Check horizontal shear and bearing.

VI. Beam Deflection

- A. Units of instruction
  1. Elastic curve, stress, and moment
  2. Moment diagrams by parts
  3. Moment-area principles
  4. Deflection equations by moment-area
  5. Use of deflection equations
- B. Laboratory
  1. Determine the general deflection equations for standard loading conditions using moment-area principles.
  2. Using the deflection equations, compute the expected deflection for certain members chosen from those selected for the framing plans in Part V.
  3. Compute the expected deflection for a laboratory test beam under various load-

ing conditions, and compare values with measured deflections of the beam.

VII. Shear and Bending in Beams—Statically Indeterminate

- A. Units of instruction
  1. Definitions
  2. Three-moment equation
  3. Use of three-moment equation
  4. Fixed-end beams
  5. Reactions and shear
  6. Shear and moment diagrams
  7. Positive and negative moments
- B. Laboratory
  1. Determine the moments at the supports in several continuous beams having three or more supports and supporting various loads. Using these loads and moments, determine the shear in the member at the supports and the moments at the middle of the span.
  2. Develop equations for moments at the ends of fixed-end members, using standard loading conditions.
  3. Specify the live load and dead load to be supported by a three-span, continuous beam, and draw the moment envelope produced by all possible arrangements of live and dead loads on the spans. Determine which loading arrangement produces maximum moments at midspan.

VIII. Stresses in Columns and Column Sizes

- A. Units of instruction
  1. Rolled steel column sections
  2. Builtup column sections
  3. Column-end conditions
  4. Effective length
  5. Allowable stresses for timber columns
  6. Allowable stresses for steel columns
  7. Timber column selection
  8. Steel column selection
  9. Eccentrically loaded columns
- B. Laboratory
  1. Select and check several standard rolled-steel sections used as columns. Use the loads from the beams and girders obtained in Part V.
  2. Provide builtup steel column sections for certain members of the same framing system.
  3. Select and check solid, spaced, and built-up timber column sections, using loads from the timber framing system in Part V.

IX. Riveted and Welded Connections

- A. Units of instruction
  1. Types of riveted connections
  2. Allowable stress in shear
  3. Allowable stress in bearing
  4. Load capacity of riveted connections
  5. Number of rivets required.
  6. Eccentrically loaded riveted connections
  7. Types of welds used in connections
  8. Allowable stresses in welds
  9. Required length of welds
- B. Laboratory
  1. Determine the number of rivets and length of weld required for various connections in tension and compressions. Prepare a drawing of the connection showing how the rivets or the welds will be arranged.
  2. Determine the force applied to each rivet in an eccentrically loaded, riveted connection in shear; and select the rivet size.
  3. Demonstrate failure of riveted connections on the testing machine. Before testing, compute the load that the connection is expected to sustain; and estimate the failure mode.

Texts and References

AMERICAN INSTITUTE OF STEEL CONSTRUCTION. *Manual of Steel Construction.*

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION. *Timber Construction Manual.*

BASSIN *and* BRODSKY. *Statics and Strength of Materials.*

JENSEN *and* CHENOWETH. *Applied Strength of Materials.*

LEVINSON. *Mechanics of Materials.*

LOTHERS. *Design in Structural Steel.*

McCORMAC. *Structural Steel Design.*

MILLER *and* DOERINGSFELD. *Mechanics of Materials.*

NATIONAL FOREST PRODUCTS ASSOCIATION. *National Design Specification for Stress-Grade Lumber and Its Fastenings.*

PARKER. *Simplified Mechanics and Strength of Materials.*

TIMBER ENGINEERING CO. *Timber Design and Construction Handbook.*

Auxiliary or Supporting Technical Courses

HISTORY OF ARCHITECTURE AND CONSTRUCTION

Hours Per Week

Class, 2

Description

This course covers the evolution of building development from primitive to modern, and is concerned with the chronological history of architectural construction.

The history of construction is considered to be a very important part of history in general, since civilizations of the past are indicated in large measure by what man built. This course should teach the student how people worshipped, lived, loved, and died; and what they glorified and what they feared—as evidenced by their buildings. It should also teach him the esthetics of good architecture.

Films and slides may be used to illustrate lectures, along with the instructor's blackboard sketches. Each student should keep a notebook.

Major Divisions

	Class hours
I. Introduction: the Science of Architecture	4
II. Prehistoric and Tigro-Euphrates Valley Civilization	2
III. Egyptian Architecture	3
IV. Greek Architecture	4
V. Roman Architecture	4
VI. Early Christian, Byzantine, and Romanesque Architecture	3
VII. Islamic Architecture	3
VIII. Gothic Architecture	3
IX. Renaissance Architecture	2
X. Revivals of Architecture	2
XI. Eclecticism, Beaux Arts, and Architecture of Today	2
Total	32

I. Introduction: the Science of Architecture
  A. Objectives of course
  B. Influences in architecture
    1. Geographical
    2. Geological
    3. Climatic
    4. Religious
    5. Social
  C. Basic principles of construction
    1. Post and lintel
    2. Corbel and cantilever
    3. Arch and vault
    4. Truss
  D. Architecture as a science as well as an art
    1. Esthetics
    2. Convenience, strength, and beauty
  E. Four categories of religious buildings
    1. Temple
    2. High place
    3. Tomb-like shrine
    4. Meeting place

II. Prehistoric and Tigro-Euphrates Valley Civilization
  A. Kinds of shelters built by prehistoric man
  B. Babylonian Period; temples, canals, and irrigation
  C. Hittites; use of stone in architecture and royal palaces
  D. Assyrian Period; house, palace, and temple forms, along with surface decorations
  E. Babylonian Empire; marvels of Babylon
    1. Hanging gardens
    2. Ziggurat
    3. Banks, storehouses, and commercial buildings
  F. Persian Period
    1. Palace platforms at Persepolis
    2. Columns

III. Egyptian Architecture
  A. Egyptian dynasty history
    1. Ancient kingdom
    2. Middle kingdom
    3. New empire

        - 4. Ptolemaic period
        - 5. Roman period
    - B. Column development
    - C. Tombs
        - 1. Mastabas
        - 2. Pyramids
        - 3. Rock-hewn tombs
    - D. Temples
- IV. Greek Architecture
    - A. An order in classic architecture
        - 1. Doric
        - 2. Ionic
        - 3. Corinthian
    - B. Proportion of the orders; module
    - C. Temples and the Acropolis
        - 1. Parthenon
        - 2. Erechtheum
    - D. Civil buildings
    - E. Agora
    - F. Theatres
    - G. Tombs
- V. Roman Architecture
    - A. Proportions of the orders by Vignola
    - B. Etruscan temples and tombs
    - C. Roman forums
    - D. Roman rectangular temples
    - E. Roman circular and polygonal temples
    - F. Basilicas
    - G. Roman baths
    - H. Roman theatres and amphitheatres
    - I. Circuses
    - J. Triumphal arches
    - K. Roman palaces and houses
    - L. Aqueducts, bridges, and fountains
- VI. Early Christian, Byzantine, and Romanesque Architecture
    - A. Development of the pendentive system in dome construction
    - B. Santa Sophia; Constantinople
    - C. St. Marks; Venice
    - D. Feudal system and structures built
    - E. Monastic system and structures built
    - F. The Romanesque church
- VII. Islamic Architecture
    - A. Mohammed's influence in styles of architecture
    - B. Mosque architecture
        - 1. Domes
        - 2. Arches
    - C. Tomb architecture
    - D. Surface development on structures
- VIII. Gothic Architecture
    - A. Departure from classic lines and development of the pointed arch
    - B. Stability of Gothic Cathedrals
    - C. Notre Dame; Paris
    - D. Amiens Cathedral
    - E. Salisbury Cathedral; Britain
    - F. Gothic architecture in Germany; Belgium, Holland, Spain, and Italy
- IX. Renaissance Architecture
    - A. The dawn of the Renaissance
        - 1. The dome of the Florence Cathedral
        - 2. Palaces and churches
    - B. The High Renaissance
        - 1. Leon Batista Alberti: "Beautiful architecture is that from which nothing can be taken away and to which nothing can be added without harming it."
        - 2. St. Peter's Cathedral, Rome; Architects who worked on this cathedral
            - a. Bramante
            - b. Peruzzi
            - c. Sangallo
            - d. Bernini
            - e. Michelangelo
            - f. Others
        - 3. City palaces and villas
    - C. Renaissance in France
    - D. Renaissance in Northern Europe
    - E. Renaissance in Spain
- X. Revivals of Architecture
    - A. The Early Classic Revival
    - B. Classic Revival ideas
    - C. Classic Revival in the United States
- XI. Eclecticism, Beaux Arts, and Architecture of Today
    - A. Influence of the Beaux Arts School
    - B. Science and art of city planning
    - C. National variations (eclecticism)
        - 1. Germany
        - 2. England
        - 3. France
        - 4. United States
    - D. Early architects of Modern Architecture and their work
        - 1. Louis Sullivan—"Chicago School"
        - 2. Frank Lloyd Wright—"Organic Architecture"
        - 3. Le Corbusier—"Geometrical Composition"
        - 4. Walter Gropius
        - 5. Mies van der Rohe

6. Eero Saarinen
7. Pier Luigi Nervi
8. Edward Durell Stone
9. Others

Texts and References

FLETCHER. *A History of Architecture.*
HITCHCOCK. *World Architecture: A Pictorial History*

CONTRACTS, CODES, SPECIFICATIONS, AND OFFICE PRACTICES

Hours Per Week

Class, 2

Description

This course explains organization and operation of the architect's, engineer's, or contractor's office. It includes the study of office practices, accounting methods, and general administration and of the codes, restrictions, standards, and the legal documents governing the construction of buildings. Considerable attention is devoted to the interpretation and preparation of good specifications, which are also treated as legal documents. References are made to manufacturers' catalogs and standards accepted in the construction industry.

Topics in the lecture periods should be illustrated by real examples and construction situation to the fullest extent possible from the instructor's experience. The student's inspection of contract documents will add greatly to the reality of lecture information. Considerable reading of reference books should be assigned throughout the course. Tests may best be given after the completion of major topics shown in the outline. Opportunity should also be provided for the student to prepare and write construction specifications.

Major Divisions

	Class hours
I. Orientation; Contracts	6
II. Codes	6
III. Specifications	16
IV. Office Practices	4
Total	32

I. Orientation; Contracts
  A. Architect-contractor-owner relationship
    1. Duties, responsibilities, and rights
    2. Fees and payments
  B. Contract documents
    1. Types
    2. Intent and interpretations
    3. Correlation and execution
    4. Rights of parties involved
    5. Liens
    6. Arbitration
  C. Subcontracts

II. Codes
  A. National
    1. Fire Underwriters
    2. Military, FHA, and other Federal codes and specifications
    3. National Electrical Code
  B. Local (city or county)
    1. Requirements based on occupancy
    2. Requirements based on fire zones
    3. Requirements based on type of construction
    4. Requirements based on plans for land use
    5. Engineering and construction requirements

III. Specifications
  A. Relationship to working drawings
    1. Precedence of information
    2. Where information is best indicated
  B. Specification material sources
    1. Codes
    2. Testing societies
    3. Government agencies
    4. Manufacturers' catalogs (for example, *Sweets' Catalog Service*)
    5. Manufacturers' associations (for example, Portland Cement Association)
    6. Model specifications

    7. Previously done specifications
    8. Federal specifications
    9. Books and magazines
    10. United States of America Standards Institute (formerly the American Standards Association)
  C. Specification formats
    1. General conditions
    2. Trade sections
    3. Small-job formats
    4. Work orders and changes
    5. Construction Specifications Institute format
  D. Specification standards
    1. Federal specifications
    2. Government specifications (FHA)
  E. Methods of preparing specifications
    1. Writing original specifications
    2. Revising similar specifications
    3. Assembly by "cut-and-paste" method
    4. Use of machine printout specifications
  F. Qualities of good specifications
    1. Clarity
    2. Logical organization
    3. Consistency
    4. Correct spelling, grammar, sentence structure, and word usage
    5. Proper designation of responsibility
    6. Correct cross-referencing
  G. Standard methods of printing and binding
    1. "Ditto" (spirit-carbon)
    2. "Mimeograph" (stencil)
    3. Offset
    4. Other (blue-line, etc.)

IV. Office Practices
  A. Organizational structures
    1. Small offices
    2. Large offices
  B. Cost accounting systems
    1. Double-entry accounting
    2. Principles of cost accounting
    3. Interorganizational flow of cost figures
  C. Reporting forms
    1. Office
    2. Field
  D. Construction estimates
    1. Breakdowns
    2. Addenda
    3. Alternates
    4. Variations in trade classifications
    5. Computation methods

Texts and References

ABBETT. *Engineering Contracts and Specifications.*
CLOUGH. *Construction Contracting.*
COHEN. *Public Construction Contracts and the Law.*
DEATHERAGE. *Construction Company Organization and Management.*
———. *Construction Office Administration.*
DYER. *Specification Work Sheets.*
EDWARDS. *Specifications.*
NATIONAL BOARD OF FIRE UNDERWRITERS. *National Building Code.*
SWEET'S CATALOG SERVICE. *Architectural File.*
U.S. FEDERAL HOUSING ADMINISTRATION. *Minimum Property Standards.*
UNITED STATES OF AMERICA STANDARDS INSTITUTE.
WATSON. *Specifications Writing for Architects and Engineers.*

TECHNICAL REPORTING

Hours Per Week

Class, 2

Description

This course, an extension of *Communication Skills*, is intended to help the student achieve greater facility in the basic skills he previously acquired. It introduces the student to the practical aspects of preparing reports and communicating within groups. The use of graphs, charts, sketches, diagrams, and drawings to present ideas and significant points is an important part of this course. Emphasis should be upon techniques for collecting and presenting scientific data in informal and formal reports and special types of technical papers. Forms and procedures for technical reports should be studied, and a pattern established for all forms to be submitted in this and other courses.

Much of the subject matter will probably be reports written for technical courses. The subject matter in this course should be coordinated with material and techniques in architectural and building construction courses.

Major Divisions

		Class hours
I.	Introduction to Reporting	2
II.	Use of Data in Reporting	6
III.	Planning Preparation of Reports	4
IV.	Writing Rough Drafts	6
V.	Use of Visual Aids in Reports	4
VI.	Editing, Redrafting, and Submitting Reports	4
VII.	Special Problems in Oral Reporting	4
VIII.	Conferences and Briefings	2
	Total	32

I. Introduction to Reporting
  A. Importance of reports
  B. Types of reports
  C. Purpose of reports
    1. Readers' needs and types of readers
    2. Background situations of reports

II. Use of Data in Reporting
  A. Data as bases for reports
  B. Sources of data
  C. Methods of recording data
  D. Evaluation and analysis of data

III. Planning Preparation of Reports
  A. Need for planning
  B. Outlining and types of outlines
  C. Methods of preparing reports
    1. Writing from "scratch"
    2. Revising existing reports
    3. Using glue-pot and scissors in preparing reports
  D. Duplication methods, format, and physical makeup
    1. Duplication methods
    2. Format
    3. Headings, pagination, footnoting, and the like
    4. Binding
    5. Special effects (typography, variation in color of ink, etc.)

IV. Writing Rough Drafts
  A. Writing of rough drafts
  B. Characteristics of effective style
    1. Conciseness
    2. Objectivity
    3. Clarity
    4. Completeness
    5. Readability
    6. Accuracy
  C. Characteristics to be avoided
    1. Slang
    2. Inconsistencies
    3. Obscurity
    4. Gobbledygook
    5. Technical errors

- D. Typical problems in writing
    - 1. Definitions
    - 2. Statements of problems, principles, and conditions
    - 3. Recommendations
    - 4. Descriptions
    - 5. Comparisons
    - 6. Narratives
    - 7. Proposals
    - 8. Inspection reports
    - 9. Progress reports
- E. Precautions to be observed
    - 1. Confidential information
    - 2. Classified information
    - 3. Copyrights and trademarks
    - 4. Liability
- F. Other parts of a written report
    - 1. Cover
    - 2. Title page and other preliminary pages

V. Use of Visual Aids in Reports

- A. Importance of visual aids in both written and oral reports
- B. Types of visual aids
    - 1. Tables
    - 2. Engineering drawings and plats
    - 3. Technical illustrations and perspectives
    - 4. Graphs and charts
    - 5. Photographs
- C. Selection of appropriate visual aids
    - 1. Analysis of reader or listener
    - 2. Analysis of information to be shown
    - 3. Analysis of available materials
- D. Reproduction of visual aids
- E. Projection or other use of visual aids for oral reports
    - 1. Readability
    - 2. Clarity
    - 3. Contrast
    - 4. Timing

VI. Editing, Redrafting, and Submitting Reports

- A. Correcting errors in usage
    - 1. Vocabulary
    - 2. Capitalization
    - 3. Abbreviation
    - 4. Punctuation
    - 5. Symbols and numerals
    - 6. Grammar
- B. Correcting factual errors
- C. Editing for conciseness and clarity
- D. Working with typists and other writers
- E. Checking the final draft
- F. Submitting the final report

VII. Special Problems in Oral Reporting

- A. Organization of material for effective presentation
- B. Preparation of formal and informal oral reports
- C. Use of notes
- D. Use of slides and other visual aids
- E. Proper control of the voice
- F. Proper control of the body; gesticulation
- G. Elimination of objectionable mannerisms
- H. Maintenance of audience interest

VIII. Conferences and Briefings

- A. Group communication
    - 1. Leading conferences
    - 2. Participating in conferences
    - 3. Solving problems in conferences and meetings
- B. Briefings
    - 1. Arranging and preparing briefings and presentations
    - 2. Conducting briefings and presentations

Texts and References

BROWN. *Communicating Facts and Ideas in Business.*
COMER *and* SPILLMAN. *Modern Business and Industrial Reports.*
DEAN *and* BRYSON. *Effective Communication.*
GRAVES *and* HOFFMAN. *Report Writing.*
HAYS. *Principles of Technical Writing.*
MARDER. *The Craft of Technical Writing.*
RHODES. *Technical Report Writing.*
THOMAS. *Composition for Technical Students.*
WEISMAN. *Basic Technical Writing.*
WEISS *and* MCGRATH. *Technical Speaking.*
ZETLER *and* CROUCH. *Successful Communication in Science and Industry.*

USE OF COMPUTERS AND NEW TECHNIQUES

Hours Per Week

Class, 2

Description

This course may well be one of the most dynamic in the program of architectural and building construction technology. The course will expose the student to the latest successful applications of data processing and other advances in technology to architecture and construction.

The course outlined below is only a framework. Any rigid prescriptions of equipment or techniques would soon become obsolete and hence defeat the purpose of the course. The instructor must make certain that (1) he keeps up with the most recent advances in technology, (2) he revises this course—within the framework suggested below—as frequently as needed. He must take advantage of opportunities to attend seminars on new architectural and building techniques; to visit architectural, civil engineering and construction offices and sites; and to undertake outside study. In short, he must prepare himself to instruct his students in the latest techniques being applied in his technology.

The outline is based on the assumption that the school will have or will have access to a computer or a data-processing unit or the capability to use computer facilities by remote computation access equipment.

Major Divisions

	Class hours
I. Survey of Recent Developments in Architecture and Building Construction Technology	4
II. Utilization of Computers and Other Data Processing Equipment	6
III. Familiarization With Computers and Other Data Processing Equipment	6
IV. Other New Techniques	10
V. Future Techniques To Be Important in Architecture and Construction	6
Total	32

I. Survey of Recent Developments in Architecture and Building Construction Technology
  - A. Research
  - B. Equipment
  - C. Techniques
  - D. Personnel and training
  - E. Relationships with other technologies

II. Utilization of Computers and Other Data Processing Equipment
  - A. Possible applications of equipment and systems
  - B. Limitations of equipment and systems
  - C. Hardware and software
  - D. Inputs and outputs
  - E. Economics of equipment and systems
  - F. Decisions about use of equipment and systems

III. Familiarization With Computers and Other Data Processing Equipment
  - A. Field trips
  - B. Practical demonstrations

IV. Other New Techniques
  - A. Management and technical approaches to problem-solving
  - B. Design and testing; simulation of field problems
  - C. Scheduling and work control
  - D. Conservation of labor and materials

V. Future Techniques To Be Important in Architecture and Construction
  A. Research reports; articles in professional journals
  B. Trends

Texts and References

AIA. *Emerging Techniques of Architectural Practice.*
———. *Check List of Drafting Room Practice.*
Ackoff. *Scientific Method.*
Booz, Allen, and Hamilton. *New Uses and Management Implications of PERT.*
Darlington, Isenberg, and Pierce. *Modular Practice.*
Evans. *AIA Research Study.*
Hansen. *Practical PERT.*
Hunt. *Comprehensive Architectural Service—General Principles and Practice.*
Shaffer, Ritter, and Meyer. *The Critical Path Method.*
Waldron. *Fundamentals of Project Planning and Control.*

General Courses

COMMUNICATION SKILLS

Hours Per Week

Class, 3

Description

The course emphasizes exercises in writing, speaking, and listening. Analysis is made of each student's strengths and weaknesses. The instruction is planned principally to help students improve skills in which they are weak. The time allotments for the various elements within major divisions will depend upon the background of the class.

Technical reporting should be considered early in the course because of its importance in the orientation of the technician to his development and use of communication skills.

Major Divisions

	Class hours
I. Communication and the Technical Specialist	2
II. Sentence Structure	6
III. Use of Resource Materials	4
IV. Written Expression	20
V. Talking and Listening	10
VI. Improving Reading Efficiency	6
Total	48

I. Communication and the Technical Specialist
  A. Summary of the technical specialist's need for proficiency in communication
  B. Discussion of written communication as an essential skill
    1. Statements and facts
    2. Expression of ideas
    3. Technical reporting
      1. Formal
      2. Informal
    4. Use of graphics to illustrate written communications
  C. Discussion of oral communications as an essential skill
    1. Person-to-person expression of ideas and thoughts
    2. Verbal reporting
  D. Diagnostic testing of students

II. Sentence Structure
  A. Review of basic parts of speech
  B. Study of complete, clear, and correct sentences
  C. Use and placement of modifiers, phrases, and clauses
  D. Study of sentence conciseness
  E. Exercises in sentence structure

III. Using Resource Materials
  A. Orientation in use of school library
    1. Location of reference materials
    2. Mechanics for effective use
    3. Dewey Decimal System (or Library of Congress system, as appropriate)
  B. Study of use of dictionaries
    1. Types of dictionaries
    2. Use of dictionaries
    3. Meanings of diacritical markings and accent marks
  C. Introduction to other reference sources
    1. Technical manuals and pamphlets
    2. Bibliographies
    3. Periodicals
    4. *Applied Science and Technology; Readers' Guide;* and other indexes
    5. Technical handbooks
    6. Standards and specifications
  D. Exercises in use of resource materials
    1. Card catalog
    2. *Readers' Guide* and other indexes
    3. Atlases
    4. Encyclopedias; dictionaries
    5. Other resources

IV. Written Expression (emphasis on student exercise)
  A. Diagnostic testing of students
  B. Study of paragraph construction
    1. Development

        2. Topic sentence
        3. Unity; coherence
    - C. Study of types of expression
        1. Narration, description, and exposition
        2. Inductive and deductive reasoning; syllogisms
        3. Figures of speech; analogies; comparisons and contrasts
        4. Cause-and-effect reasoning
        5. Other
    - D. Written exercises in paragraph construction
    - E. Study of descriptive reporting
        1. Organization and planning
        2. Emphasis on sequence, continuity, and delimitation to pertinent data or information
    - F. Study of letter writing
        1. Business letters
        2. Personal letters
    - G. Review of mechanics
        1. Grammar (reviewed as required)
        2. Punctuation—when to use
            - a. Period, question mark, and exclamation point
            - b. Comma
            - c. Semicolon
            - d. Colon
            - e. Dash
            - f. Parentheses
            - g. Apostrophe
        3. Capitalization
        4. Spelling
            - a. Word division—syllabification
            - b. Prefixes and suffixes
            - c. Word analysis and meaning—context clues and phonetics
    - H. Exercises in mechanics of written expression
- V. Talking and Listening (emphasis on student exercises)
    - A. Diagnostic testing of students
    - B. Organization of topics or subjects
    - C. Directness in speaking
    - D. Gesticulation and use of objects to illustrate
    - E. Conversation courtesies
    - F. Listening faults
    - G. Taking notes
    - H. Understanding words through context clues
    - I. Exercises in talking and listening
- VI. Improving Reading Efficiency
    - A. Diagnostic testing of students
    - B. Improvement of reading habits
        1. Correct reading posture
        2. Light sources and intensity
        3. Developing proper eye-span and movement
        4. Developing speed and comprehension appropriate to the purpose
        5. Scanning; sentence reading
        6. Taking notes for careful study
    - C. Footnotes, index, bibliography, and cross-references
    - D. Developing skill in summarizing
        1. Outline
        2. Digest or brief
        3. Criticism
    - E. Exercises in reading improvement
        1. Reading for comprehension
        2. Reading for speed

Texts and References

BAIRD *and* KNOWER. ***Essentials of General Speech.***

BEARDSLEY. ***Thinking Straight: Principles of Reasoning for Readers and Writers.***

BUCKLER *and* MCAVOY. ***American College Handbook of English. Fundamentals.***

COWAN. ***Plain English Please.***

DEAN *and* BRYSON. ***Effective Communication.***

DEVITIS *and* WARNER. ***Words in Context: A Vocabulary Builder.***

GRIGGS *and* WEBSTER. ***Guide and Handbook for Writing.***

HODGES *and* WHITTEN. ***Harbrace College Handbook.***

KIRSCHBAUM. ***Clear Writing.***

LEGGETT, MEAD, *and* CHARVAT. ***Handbook for Writers.***

PERRIN *and* SMITH. ***Handbook of Current English.***

ROGET. ***New Roget's Thesaurus of the English Language.***

STEWART and others. ***Business English and Communication.***

THOMAS. ***Composition for Technical Students.***

WATKINS, MARTIN, *and* DILLINGHAM. ***Practical English Handbook.***

WITTY. ***How to Become a Better Reader.***

ZETLER *and* CROUCH. ***Successful Communication in Science and Industry: Writing, Reading, and Speaking.***

A current dictionary

Visual Aids

Coronet Films, Inc., Coronet Building, Chicago, Ill. 60601.
Improve Your Punctuation, 16 mm., 11 min., sound, b/w or color.

National Education Television Film Service, Audio Visual Center, Indiana University, Bloomington, Ind. 47405. (The following films are black and white)
The Definition of Language, 16 mm., 29 min., sound. Produced by Henry Lee Smith. (Language in Linguistics Series)
Dialects, 16 mm., 29 min., sound. Produced by Henry Lee Smith. (Language in Linguistics Series)
How to Say What You Mean, 16 mm., 29 min., sound. Produced by S. I. Hayakawa. (Language in Action Series)

Language and Writing, 16 mm., 29 min., sound. Produced by Henry Lee Smith. (Language in Linguistics Series)

The Task of the Listener, 16 mm., 29 min., sound. Produced by S. I. Hayakawa. (Language in Action Series)

What is the Meaning? 16 mm., 29 min., sound. Produced by S. I. Hayakawa. (Language in Action Series)

DuArt Film Laboratories Inc., 245 West 55th Street, New York, N.Y. 10019.

Films which *may* be available for loan:

Effective Writing, 16 mm., 19 min., sound, b/w. U.S. Department of the Air Force. Order No. TF1-5072.

Practical English Usage, Lecture 1: The Tools of Language, 16 mm., 30 min., sound, b/w.

Practical English Usage I, Lecture 10: Writing Clear Sentences: Making Words Agree, 16 mm., 30 min., sound, b/w.

Practical English Usage I, Lecture 13: Dressing Up Sentences: Parallelism: Avoidance of Shifts, 16 mm., 30 min., sound, b/w.

Practical English Usage I, Lecture 14: Dressing Up Sentences: Word Economy (Word Reduction), 16 mm., 30 min., sound, b/w.

Practical English Usage I, Lecture 15: Dressing Up Sentences: Variation, 16 mm., 30 min., sound, b/w.

GENERAL AND INDUSTRIAL ECONOMICS

Hours Per Week

Class, 3

Description

The course in economics enables the student to understand the basic principles of economics and their implications, to develop the ability to follow an informed personal finance program, to aid him in becoming an intelligent consumer, and to understand the underlying relationship of finance and cost control to success in construction enterprises.

The programs or problems worked upon by architectural and building construction technicians ultimately must be measured by analyses. To be aware of this fact and to have a knowledge of elementary economics prepare the student for the cost-conscious environment of his future employment. It is suggested that the instructor adopt a pragmatic approach and that he encourage the student to study examples from construction and other industry as he learns about industrial cost analysis, competition, creation of demand, economic production, and the related aspects of applied economics.

Major Divisions

	Class hours
I. Introduction: Basic Economic Concepts	2
II. Economic Forces and Indicators	3
III. Natural Resources: The Basis of Production	3
IV. Capital and Labor	3
V. Business Enterprise	7
VI. Factors in Construction and Other Production Costs	8
VII. Price, Competition, and Monopoly	5
VIII. Distribution of Income	2
IX. Personal Income Management	2
X. Insurance, Personal Investments, and Social Security	3
XI. Money and Banking	3
XII. Government Expenditures, Federal and Local	3
XIII. Fluctuations in Production, Employment, and Income	2
XIV. The United States Economy in Perspective	2
Total	48

I. Introduction: Basic Economic Concepts

II. Economic Forces and Indicators
  A. Economics defined
  B. Modern specialization
  C. Increasing production and consumption
  D. Measures of economic activity, including:
    1. Gross national product
    2. National income
    3. Disposable personal income
    4. Industrial production
    5. Employment and unemployment
    6. Consumer Price Index
    7. Housing starts
    8. Construction contracts
    9. Federal Reserve indexes

III. Natural Resources: The Basis of Production
  A. Utilization and conservation of resources
  B. Renewable resources
  C. Nonrenewable resources
  D. Future sources

IV. Capital and Labor
  A. Tools (Capital)
    1. The importance of saving and investment
    2. The necessity for markets
  B. Large-scale and small-scale enterprises
  C. Labor
    1. Population characteristics
    2. Vocational choices
    3. General education
    4. Special training

    - 5. Management's role in maintaining the labor supply
- V. Business Enterprise
  - A. Forms of business enterprise
    - 1. Individual proprietorship
    - 2. Partnership
    - 3. Corporation
  - B. Types of corporation and other securities
    - 1. Common stocks
    - 2. Preferred stocks
    - 3. Bonds
    - 4. Debentures
    - 5. Mortgages
    - 6. Convertible issues
  - C. Mechanics of financing business
    - 1. Equity financing
    - 2. Debt financing
  - D. Company organization and management
- VI. Factors in Construction and Other Production Costs
  - A. Buildings and equipment
    - 1. Initial cost and financing
    - 2. Repair and maintenance costs
    - 3. Depreciation and obsolescence costs
  - B. Materials
    - 1. Initial cost and inventory value
    - 2. Handling and storage costs
    - 3. Accountability of materials
  - C. Processing and production
    - 1. Methods of cost analysis
    - 2. Cost of labor
    - 3. Cost of supervision and process control
    - 4. Effect of losses in percentage of original product compared to finished product (yield)
  - D. Purchasing and ordering
  - E. Packaging, storage, and shipping
  - F. Indirect costs, including taxes
  - G. Cost of selling
  - H. Process analysis, a means to lower costs
  - I. Profitability and business survival
- VII. Price, Competition, and Monopoly
  - A. Function of prices
  - B. Price determination
    - 1. Competitive cost of product
    - 2. Demand
    - 3. Supply
    - 4. Interactions between supply and demand
  - C. Competition, benefits, and consequences
    - 1. Monopoly and oligopoly
    - 2. Forces that modify and reduce competition
    - 3. History of Government regulation of competition
  - D. Competitiveness of the economy
- VIII. Distribution of Income
  - A. Increasing real incomes
  - B. Marginal productivity
  - C. Supply in relation to demand
  - D. Income resulting from production
    - 1. Wages
    - 2. Interest
    - 3. Rents
    - 4. Profits
  - E. Income distribution today
- IX. Personal Income Management
  - A. Consumption—the core of economics
  - B. Economizing defined
  - C. Personal and family budgeting
  - D. Analytical buying
    - 1. Applying quality standards
    - 2. Consumers Union and similar groups
  - E. The use and abuse of credit
  - F. Housing—owning or renting
- X. Insurance, Personal Investments, and Social Security
  - A. Insurance defined
  - B. Life insurance
    - 1. Group, industrial, and ordinary life policies
    - 2. Types of policies; their advantages and disadvantages
  - C. Casualty and other insurance
    - 1. Liability
    - 2. Workmen's compensation
    - 3. Federal Housing Authority
    - 4. Housing and urban development
  - D. Investments
    - 1. Savings accounts and government bonds
    - 2. Annuities
    - 3. Pension plans
    - 4. Corporation bonds
    - 5. Corporation stocks
    - 6. Other speculations
  - E. Social Security and other insurance and retirement plans
    - 1. Old age and survivors insurance
    - 2. Unemployment compensation
    - 3. Medicare
    - 4. Other retirement plans
- XI. Money and Banking
  - A. Functions of money
  - B. The Nation's money supply; money standards

C. Organization and operation of banks, savings and loan associations, and other financial institutions
    1. Sources of deposits and shares
    2. The reserve ratio
    3. Expansion of bank deposits and shares
    4. Sources of reserves
    5. Secondary financing

D. The Federal Reserve System
    1. Service functions
    2. Control of money supply

E. Federal Depositors Insurance Corp.

F. Federal National Mortgage Association

G. Small Business Administration

H. Federal Savings and Loan Association

I. Insurance companies

XII. Government Expenditures, Federal and Local

A. Economic effects

B. Functions of government

C. Analysis of government spending

D. Future outlook

E. Financing government spending
    1. Criteria of sound taxation
    2. Tax revenues in the United States
    3. Federal and State personal income taxes
    4. Corporate income tax
    5. Property and other taxes
    6. Commodity taxes
    7. Government indebtedness

F. Governmental—private; combination financing

XIII. Fluctuations in Production, Employment, and Income

A. Changes in aggregate spending

B. Output and employment

C. Other factors in economic fluctuations
    1. Cost-price relationships
    2. Fluctuations in demand for durable goods
    3. Involuntary fluctuation of supply of commodities
    4. Inflation and deflation of currency value
    5. Economic effects of inventions and automation
    6. Economic effects of government actions related to construction

D. Means of implementing fiscal policy

E. Government debt
    1. Purposes of government borrowing
    2. Extent of the debt burden
    3. Problems of debt management

XIV. The United States Economy in Perspective

A. Recent economic changes
    1. Increased productivity and construction; well-being
    2. Effects of war and depression
    3. New products and industries
    4. Increase in government controls

B. Present economic problems of U. S. economy
    1. The world market—a community of nations
    2. International cooperation
    3. Maintenance of prosperity, progress, and production
    4. Economic freedom and security

C. Communism: nature and control by Soviet State

D. Fascism

E. Socialism

F. Problems common to all economic systems

G. Special economic problems of the United States

Texts and References

DONALDSON and PFAHL. *Personal Finance.*
DUNLOP. *Automation and Technological Change.*
DYE. *Economics: Principles, Problems, Perspectives.*
EDWARDS. *The Nation's Economic Objectives.*
GORDON. *Economics for Consumers.*
KATONA. *The Mass Consumption Society.*
LYNN. *Basic Economic Principles.*
MCCONNELL. *Economics: Principles, Problems, and Policies.*
REYNOLDS. *Economics: A General Introduction.*
SAMUELSON. *Economics: An Introductory Analysis.*
SCHULTZ. *The Economic Value of Education.*
Business Week Magazine.
Consumers Union Reports.
Engineering News-Record Magazine.
Fortune Magazine.
Harvard Business Review.

Visual Aids

McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, N.Y. 10036.
Basic Economic Concepts, 35 mm., filmstrip—set of 4 filmstrips, average 40 frames each, black and white.
Business Cycles and Fiscal Policy.
Money, Prices, and Interest.
Savings and Investments.
Supply and Demand.

INDUSTRIAL ORGANIZATIONS AND INSTITUTIONS

Hours Per Week

Class, 3

Description

This course describes and analyzes the roles of labor and management in the economy of the United States. Approximately half of the classroom time is devoted to labor-management relations, including the evolution and growth of the American labor movement and the development and structure of American business management. A study is made of the legal framework within which labor-management relations are conducted and the responsibilities of each in a democratic system of government. The second half is devoted to labor-economics as applied to the forces affecting labor supply and demand, problems of unemployment and wage determination on the national, plant, company, and individual levels. Emphasis centers upon current aspects of industrial society, with historical references only as a background.

Major Divisions

	Class hours
I. Labor in an Industrial World	9
II. Management in an Industrial Society	9
III. The Collective Bargaining Process	12
IV. Dynamics of the Labor Market	8
V. Wage and Salary Determination	7
VI. The Balance Sheet of Labor-Management Relations	3
Total	48

I. Labor in an Industrial World
A. The nature and scope of the Industrial Revolution
1. The factory system
2. Occupational trends
3. Mechanisms of adjustments
B. The evolution of American labor unions
1. Nature of early unions; basic system of craft unions
2. Organizations by unions for solving problems
3. Development of business unionism
4. The changing role of government
C. Structure and objectives of American unions
1. Objectives in collective bargaining
2. Political objectives and tactics
3. Structure of craft and industrial unions
4. Movement toward unity—the AFL–CIO merger
5. Conduct of local unions

II. Management in an Industrial Society
A. The rise of big business
1. Economic factors
2. Dominance of the corporation
3. Government, public policy, and big business
B. The managerial revolution
1. Changing patterns of ownership and management
2. Scientific management
3. Twentieth-century trends
C. Structure and objectives of American industry
1. Production for profit: an affluent society
2. Structure of industry—organizational forms
3. Ethics in a competitive economy

III. The Collective Bargaining Process
A. Legal framework
1. Common law provisions
2. The growth of statute laws
3. National Labor Relations Board rulings
4. Specific laws; court decisions
a. The antitrust laws; effects on collective bargaining
b. The Adamson and La Follette laws
c. Norris-LaGuardia law

        - d. Walsh-Healy law
        - e. Wagner law
        - f. Fair Labor Standards law
        - g. Taft-Hartley law
        - h. Landrum-Griffin law and beyond
  - B. Management and collective bargaining
  - C. Bargaining procedures and tactics, including mediation
  - D. Issues and areas of agreement in collective bargaining
    - 1. Security issues
    - 2. Working conditions
    - 3. Safety provisions and safety education
    - 4. Money matters
  - E. Strikes and lockouts; tactics and prevention
  - F. Evaluation of collective bargaining

IV. Dynamics of the Labor Market
  - A. Labor supply and the market
    - 1. Level and composition of the labor force
    - 2. Changing patterns of employment
    - 3. Some questions about labor supply and the market
  - B. Reduction and control of unemployment
    - 1. Types of unemployment
    - 2. Proposed schemes of employment stabilization
    - 3. Continuing problems
  - C. Labor mobility
    - 1. Types of labor mobility
    - 2. Deterrents to labor mobility
    - 3. Suggested programs to improve labor mobility

V. Wage and Salary Determination
  - A. Wages, salaries, processes, and employment
    - 1. Definition of wages and salaries
    - 2. Wages and the productive process
    - 3. The problem of inflation
  - B. Wages and the national income
    - 1. Concepts of measurement and productivity
    - 2. Determinants of productivity
    - 3. The distribution of national income
  - C. Wage structures
    - 1. Occupational differences
    - 2. Geographic patterns
    - 3. Industry patterns
    - 4. Wage determination; plant level; individual wages

VI. The Balance Sheet of Labor-Management Relations
  - A. The control and elimination of poverty in a modern industrial state
    - 1. The extent of poverty
    - 2. The attack on poverty
    - 3. Trends and portents
  - B. Justice and dignity for all in an industrial democracy
    - 1. The worker—status and goals
    - 2. Management—rights and responsibilities
    - 3. The future of capitalistic society

Texts and References

ADRIAN. *State and Local Governments.*
BACH. *Economics: An Introduction to Analysis and Policy.*
BELL. *Crowd Culture.*
BIESANZ *and* MAVIS. *Modern Society: An Introduction to Social Science.*
BISHOP *and* HENDLE. *Basic Issues of American Democracy.*
CARR, BERNSTEIN, *and* MORRISON. *American Democracy in Theory and Practice.*
CHAMBERLAIN. *Sourcebook on Labor.*
CHINOY. *Society: An Introduction to Sociology.*
GEORGE. *Management in Industry.*
IRISH *and* PROTHRO. *The Politics of American Democracy.*
MARK *and* SLATER. *Economics in Action.*
OGG *and* RAY. *Essentials of American Government.*
PELLING. *American Labor.*
PHELPS. *Introduction to Labor Economics.*
SOROKIN. *Crisis of Our Age.*
WALLETT. *Economic History of the United States.*

Visual Aids

Encyclopedia Britannica Films, 1150 Wilmette Avenue, Wilmette, Ill. 60091.
- *Man and His Culture*, 16 mm., 15 min., sound, black and white.
- *Productivity—Key to Plenty*, 16 mm., 20 min., sound, black and white.

McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, N.Y. 10036.
- *Social Classes in America*, 16 mm., 16 min., sound, black and white.
- *The Rise of Organized Labor*, 16 mm., 18 min., sound, black and white.

FACILITIES, EQUIPMENT, AND COSTS

General Planning of Facilities

Drawing rooms, laboratories, classrooms, offices, and storage facilities for teaching architectural and building construction technology do not require unusual conditions. Most well-constructed buildings with suitable facilities for water, heat, light, ventilation, plumbing, and other utilities may be used. Even multistory buildings lend themselves to accommodating drawing rooms, classrooms, and offices where satisfactory stairways and halls permit the necessary student traffic and communication.

Laboratories with heavy equipment should be placed on the lower floor. In particular, the materials laboratory, requiring a heavy machine, should be located on ground level where solid foundations will support the concentration of weight. Otherwise, a building having abundant windows for natural lighting, preferably north light, will be especially suitable for this program.

Adequate washroom and toilet facilities should be provided. In multilevel buildings these facilities should best be provided on each floor. If washrooms must be placed remote from drawing rooms, small fixtures should be provided in or near the drawing rooms so that students may wash their hands without inconvenience. Both warm and cold water should be provided in washrooms and in all laboratories. Space must be allowed for proper storage of janitorial equipment and supplies.

Electrical services should provide both 110- and 220-volt current for the materials and model-building laboratories. Most of the equipment in these laboratories will be more economically operated with 220-volt circuits. The drawing rooms and classrooms and other areas should be well provided with 110-volt duplex outlets. Control panels for electrical apparatus should be centrally located, with the circuit breaker for each circuit with ample capacity to prevent overloading. Laboratories with considerable electrical equipment should have separate distribution control panels which can be locked for security.

Both classrooms and laboratories as well as offices should be well lighted. A minimum of 70 foot-candles of light is recommended on all work surfaces of classrooms, offices, and general laboratories. In all rooms where drafting must be done, a minimum of 100 foot-candles of light, exclusive of natural light, should be provided. Fixtures should be selected to provide a comfortable, uniform light throughout the room; usually fluorescent-type light is the most satisfactory. Lighting fixtures should be arranged diagonal to the tables in drafting rooms (see figs. 15 and 16). This arrangement of lighting prevents drawing-equipment shadows from appearing on the drawing surface.

Mechanical equipment which provides constant temperature and humidity control within drafting rooms is very desirable. Air in these areas should be within comfortable temperature and humidity ranges and should be circulated with sufficient amounts of outside air to keep air in rooms suitably fresh. In warm climates, year-round air conditioning is recommended.

Faculty offices may best be placed in small clusters near classrooms and laboratories. No more than two faculty members should be placed in each office, but several offices can be combined with an outer office for a secretary or receptionist so that several instructors may share secretarial service. As in drawing rooms, air conditioning (in warm climates) is desirable. Each faculty member should have a minimum of 150 square feet of office space.

If plans are being made to start an architectural and building construction program in an institution which already offers programs in other technologies, a careful analysis should be made of existing classrooms and laboratories to determine the feasibility of using them. Some of the space provisions might not have to be duplicated for the new program. This discussion assumes that conventional classrooms, offices, lecture rooms,

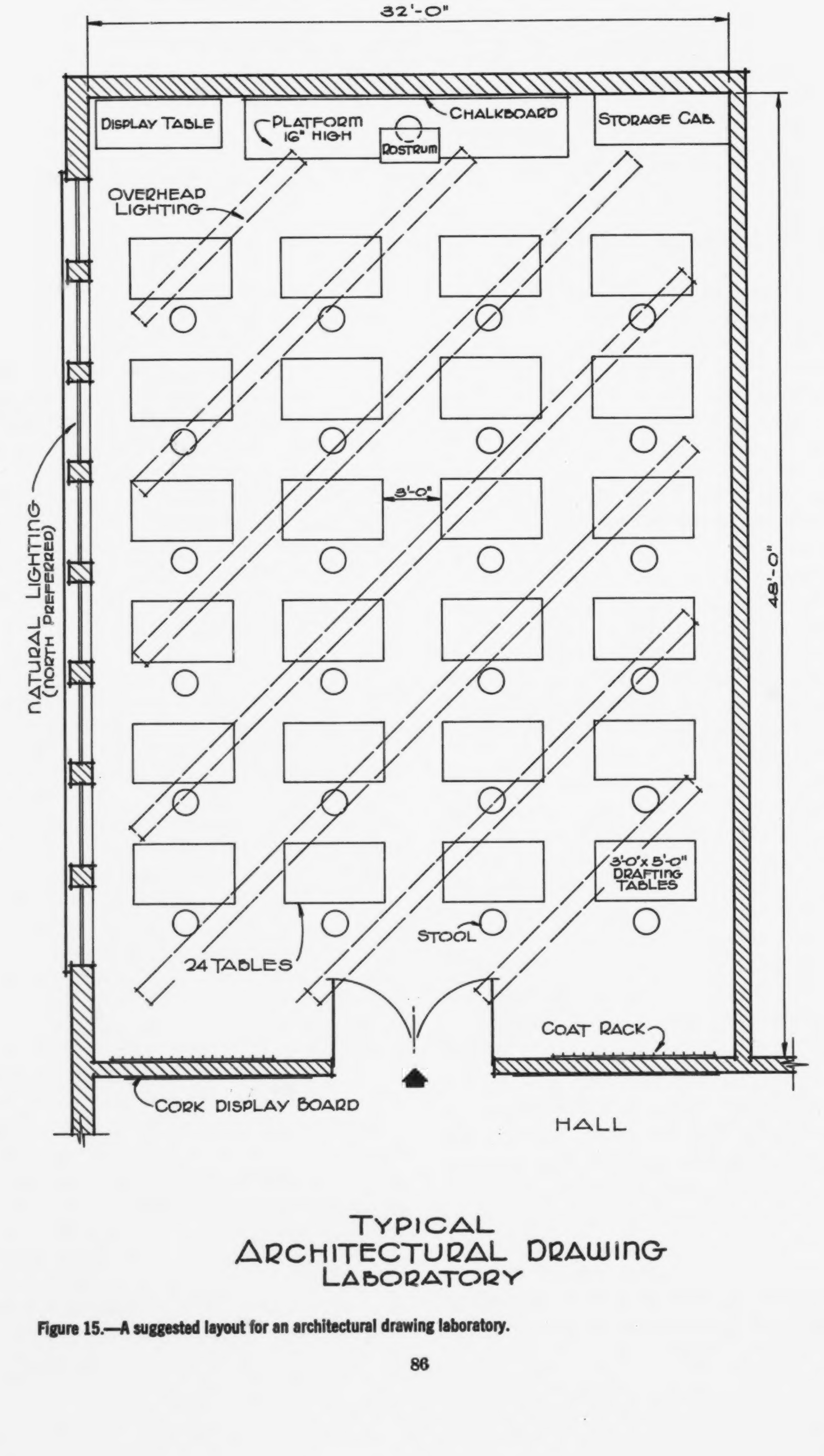


Figure 15.—A suggested layout for an architectural drawing laboratory.

and the necessary related accommodations are already available. Therefore, only the physical facilities specifically identifiable with the technical specialty are described. Since the classrooms, laboratory facilities, and laboratory equipment required for the two physics courses for architectural and building construction technology are conventional, the details are not presented here.

The requirements for the technical specialty are unusual. Therefore, the minimum facilities and equipment required are described in some detail. Facility plans and estimates are based on 24 students—the maximum number recommended in the specialty courses. If the facilities are available, lecture courses may be larger, possibly up to 50 students.

ARCHITECTURAL DRAWING LABORATORIES

Two typical drawing room floor plans are shown in figures 15 and 16. The floor plan in figure 16 calls for small (24 by 30 inch) drafting tables. The small tables can be used for beginning drawing courses requiring only small drawings. This room lends itself to lecture and problem-solving classes where students must work from books, tables, and drawings or sketches. The room also is suitable for beginning drafting classes taught as service courses for other curriculums and for adult evening classes which are usually taught in institutions providing technician educating programs.

Figure 15 shows the standard 3 by 5 feet drawing tables recommended for the full range of architectural drawing courses. Heavy-duty tables with adjustable basswood tops should be purchased; sturdy, steel drafting stools will be found to be most serviceable. Each table should be equipped with a parallel bar to provide each student with a convenient and professional work station. The 3 by 5 feet drawing tables are recommended for all drawing courses after the beginning drawing course.

As shown in the figures, a standard blackboard is provided on the front wall, and a 16-inch high platform is provided to allow students at the drawing tables to see and hear the instructor satisfactorily. A table for models and demonstration equipment should be available in the front of the room. Cabinet space should be provided for storage of supplies and equipment. Cork boards for display of students' work may best be placed directly outside the room in a hall or passageway.

Sufficient lighting is of paramount importance in drafting rooms. Provisions should be as generous as possible for natural lighting, which should be from the left, as indicated on the layout. However, no direct sunlight should be allowed to fall upon the drafting tables. Artificial lighting should be adequate to allow for dark days and night classes; and fluorescent fixtures, placed in a diagonal position in relation to the tables, should provide at least 100 foot-candles of comfortable light on the tabletops. Walls and ceilings should be painted in light, pleasing colors to reflect light and provide a comfortable atmosphere for concentration. Vinyl tile flooring of intermediate tone provides a bright yet durable and resilient floor surface.

MATERIALS TESTING LABORATORY

This laboratory (see layout figure 17) should have ample floorspace and worktable space for test materials and representative models of structures. Note the spacing of the testing machine with sufficient floorspace around it to provide for testing structures and also to enable students to observe tests being performed.

The layout of this laboratory revolves around the placement of the testing machine. This laboratory should therefore be placed on the ground floor to accommodate the dead weight concentration; a double door is necessary to allow for the installation of the testing machine.

Since demonstrations must be made at the machine and students must be directly around it to observe them, at least 6 feet of clearance should be allowed around the testing machine. Worktables are shown for computations and blackboard discussions, and the instructor has access to both the blackboard and the testing machine during lectures. A supplementary table is shown for display of tested and ruptured materials. An isolated storage room for supplies and equipment is needed, with entrance doors in to a hallway and the laboratory.

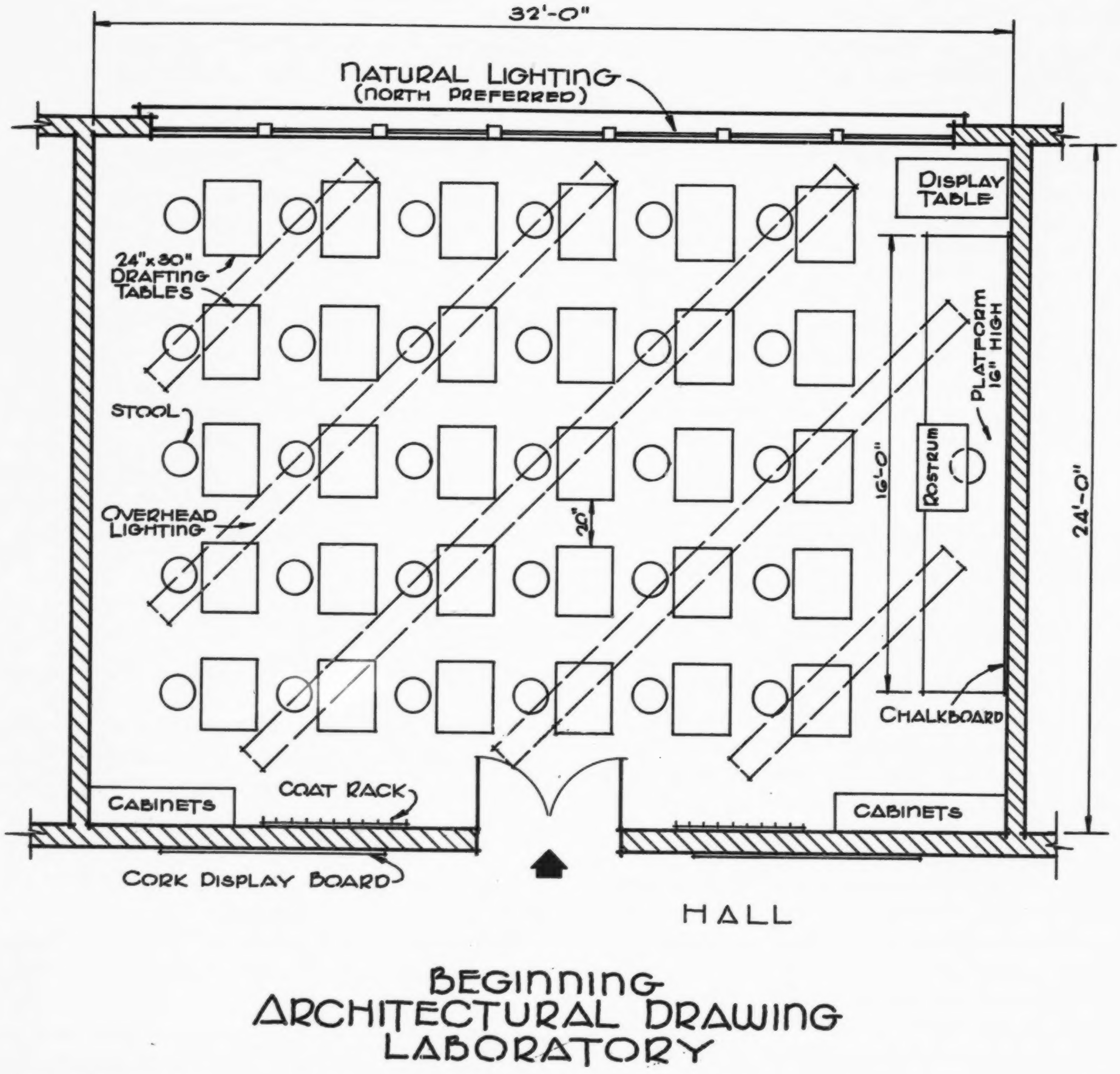


Figure 16.—An example of an architectural drawing laboratory where students begin to learn the elements of architectural drawing and drafting.

MODEL BUILDING LABORATORY

The worktables in this laboratory allow students to construct architectural models in group projects (see figures 18 and 19).

Safety precautions must be continually emphasized. The small woodworking machines are purposely placed away from the work stations for safety. A sturdy workbench is shown in the corner for supplementary layout and manual work. Well-designed woodworking machines with guarded belts and pulleys should be selected. On-and-off switches should be easily accessible on each machine. Demonstrations, stressing safety precautions on the use of woodworking machines, must be given before students are allowed to use any of the power tools.

Provision must be made for lumber and plywood storage, and for a separate toolroom with adequate cabinets and racks for handtool storage.

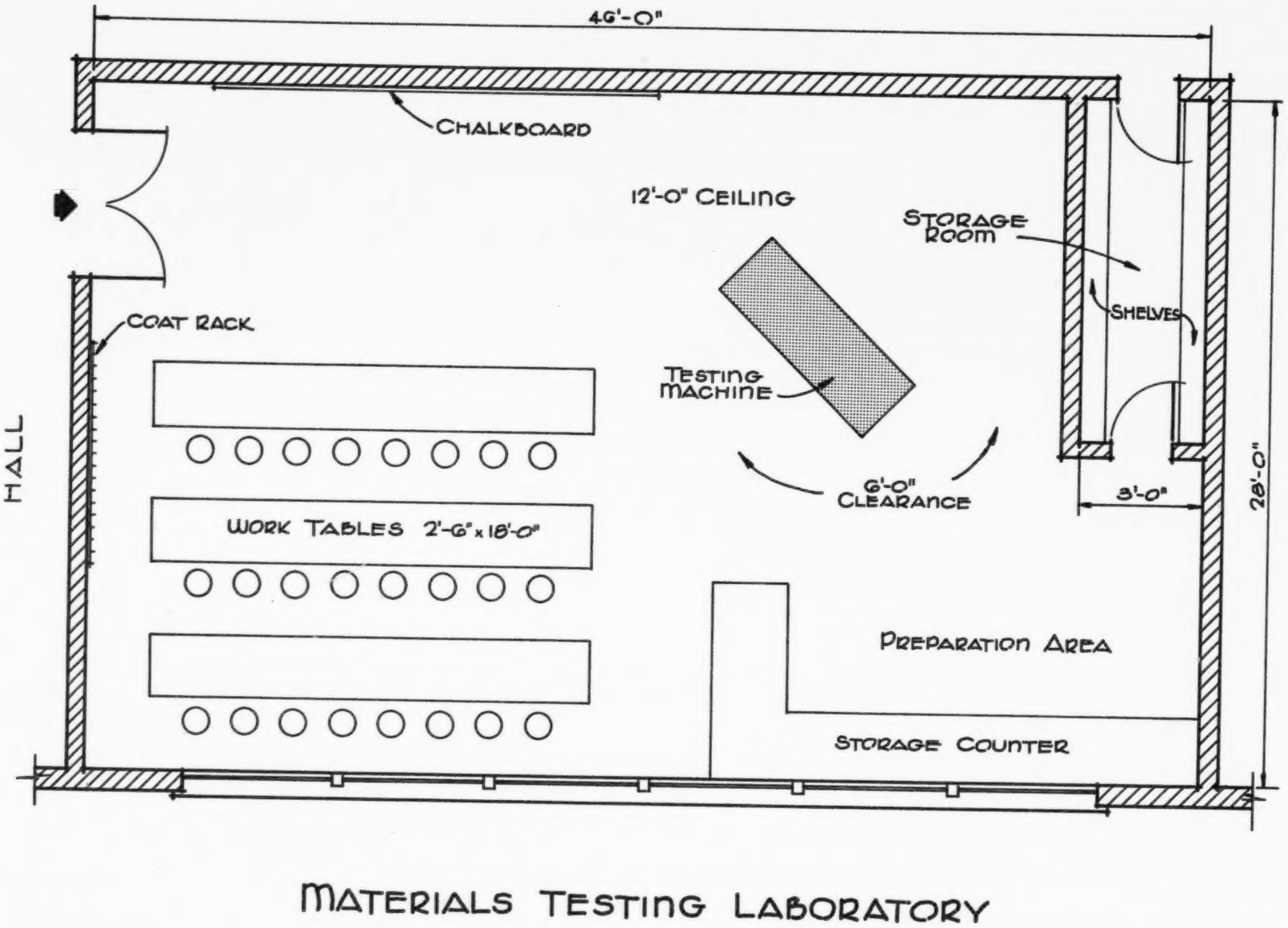


Figure 17.—Materials-testing laboratory.

Small stools should be provided at the work stations. Circuits of 220 volts are necessary for operating the power tools in this laboratory, and sufficient 110-volt duplex outlets should be installed near the work stations. Hot and cold water should be provided at a washbasin for cleanup and for model-building work. If paints are stored in the laboratory, a fireproof storage area must be installed. Fluorescent fixtures providing 70 footcandles of light on the worktables and machines are recommended. Forced ventilation will prevent the accumulation of dust from the machines and provide comfortable air within the area.

REPRODUCTION ROOM

The drawing instructors and students must have access to a reproduction machine, which usually is located in a separate room (see figure 20). Modern diazo machines are versatile—even capable of making transparencies for overhead projectors—and should be located in a separate room in the building near the drawing rooms. Machines using ammonia for developing require a roof vent directly from the machine; even an auxiliary vent with a forced fan to the outside from the room itself is recommended. A 220-volt circuit is usually required to operate the larger machines.

Sufficient space should be provided for a worktable near the machine. A large paper cutter is also suggested to facilitate cutting various sized reproductions. A water outlet and fixture are needed in or near this room. Storage of sensitive reproduction paper in areas other than the reproduction room is recommended. The minimum size recommended for a reproduction room is 150 square feet.

Before purchasing any types of reproduction machines and other required equipment for school use, officials should thoroughly investigate the availability of Federal surplus equipment. Often

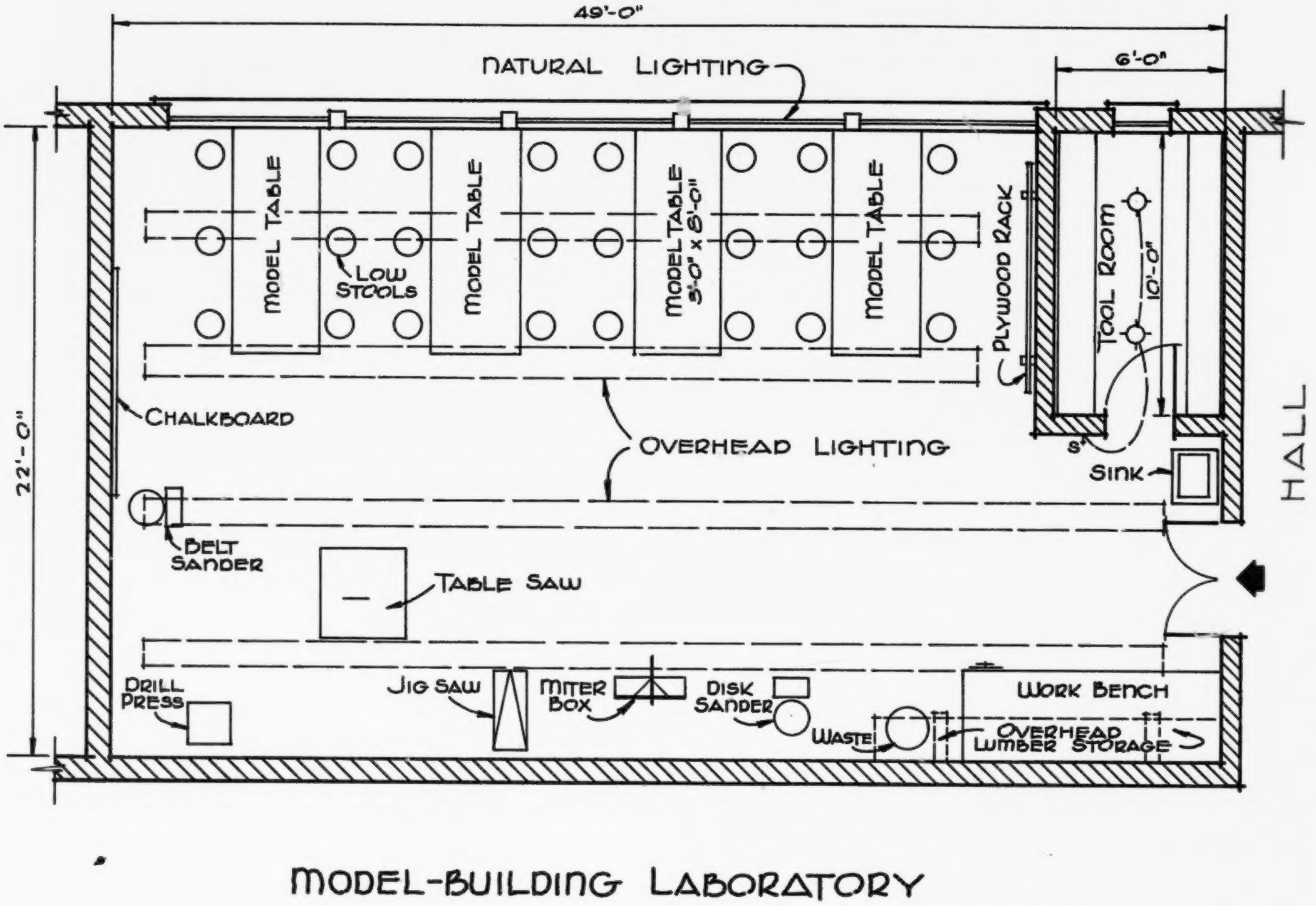


Figure 18.—A model-building laboratory.

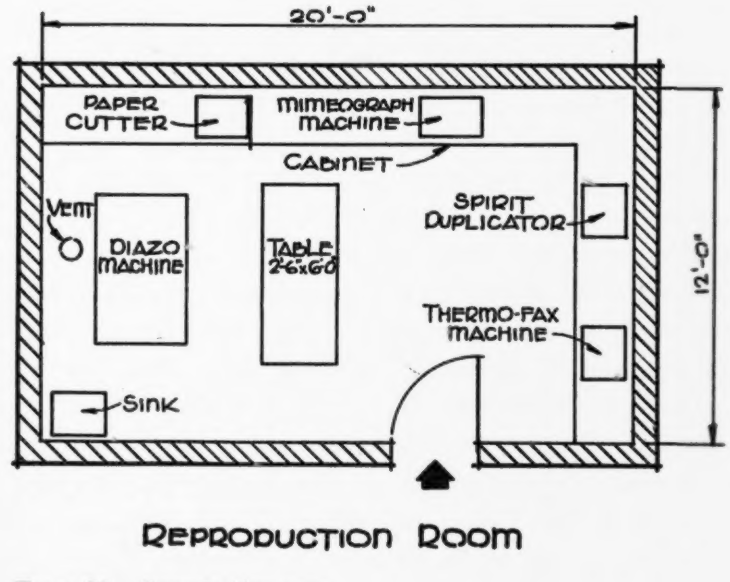


Figure 20.—Reproduction room.

Figure 19.—The model-making laboratory equipped with proper machinery enables students to build models such as this one, accurately and to scale.

considerable amounts can be saved if the equipment available meets the requirements of a school program. (See page 96 for further information on procurement of Federal surplus materials for school use.)

BUILDING MATERIALS DISPLAY AREA AND LECTURE ROOM

Because of their functional compatability, these areas may be combined into one room, as shown in figure 21. However, if space is available, separate rooms for each activity may be a better arrangement.

Building materials can be displayed in a typical classroom with samples and specimens of materials available. Material samples must be organized and carefully maintained in this lecture room. Experience has shown that without proper shelving or cabinetwork to accommodate such teaching aids, they soon deteriorate and clutter the room. The shelving, indicated in figure 22, should be of sturdy steel that can be assembled at various heights to fit various sizes of material samples. Some sample materials are best kept in glass-enclosed cabinets to prevent dust from ruining the samples and to allow students to see them.

A good quality 16 mm. projector is satisfactory for most technical films. It should be permanently mounted on a stand near the back of the room. A retractable 6 by 8 feet screen can be conveniently mounted above the blackboard on the front wall and pulled down in place when needed, forming a satisfactory, yet versatile arrangement. Complete blackout shades for all windows must be installed.

As figure 21 indicates, 48 tablet armchairs are recommended in this room to provide space for possible double sections viewing a film. (Occasionally other large groups require school projection room facilities.) The room should have good acoustical qualities and ample forced ventilation to make the viewers comfortable when blackout shades are in place.

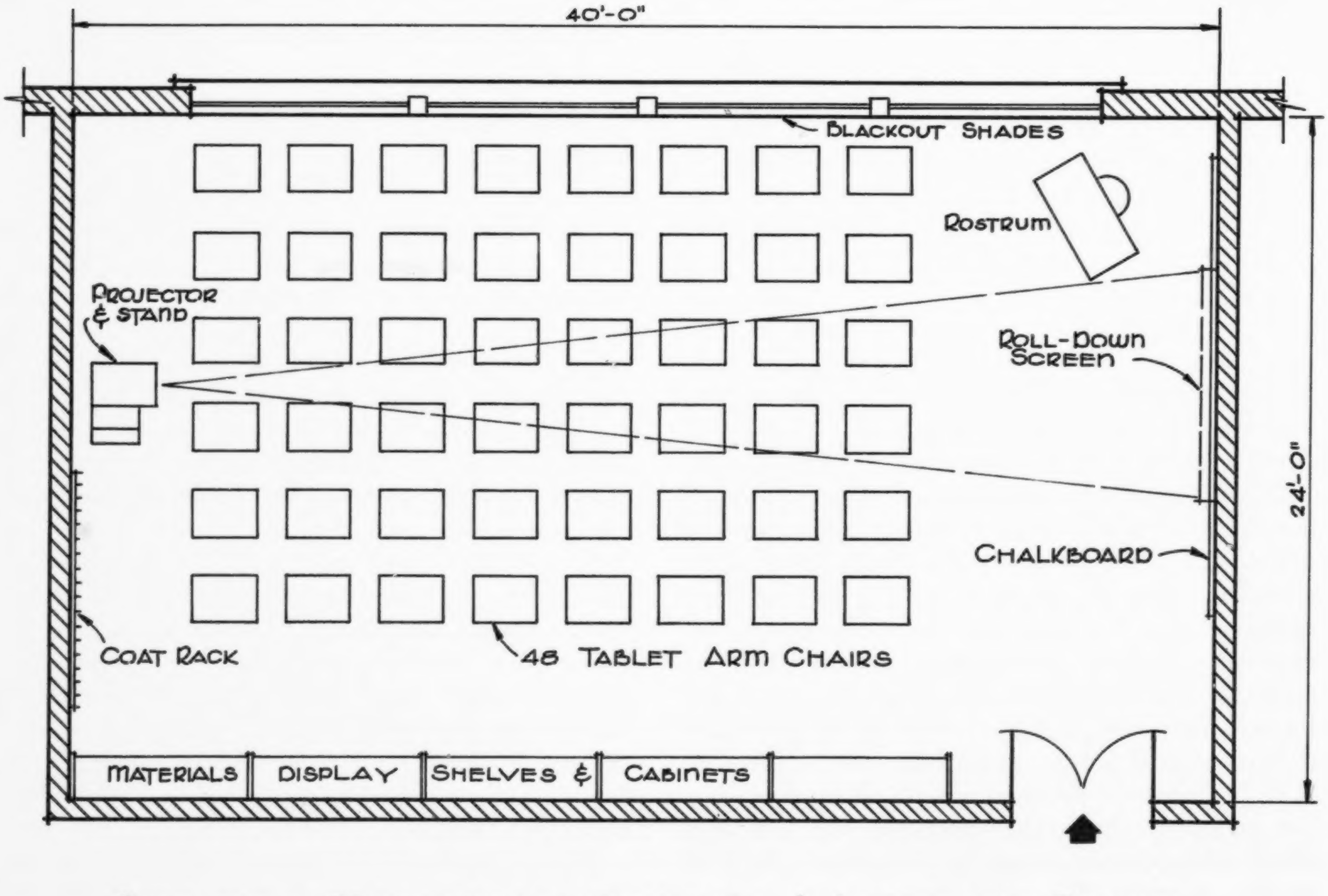
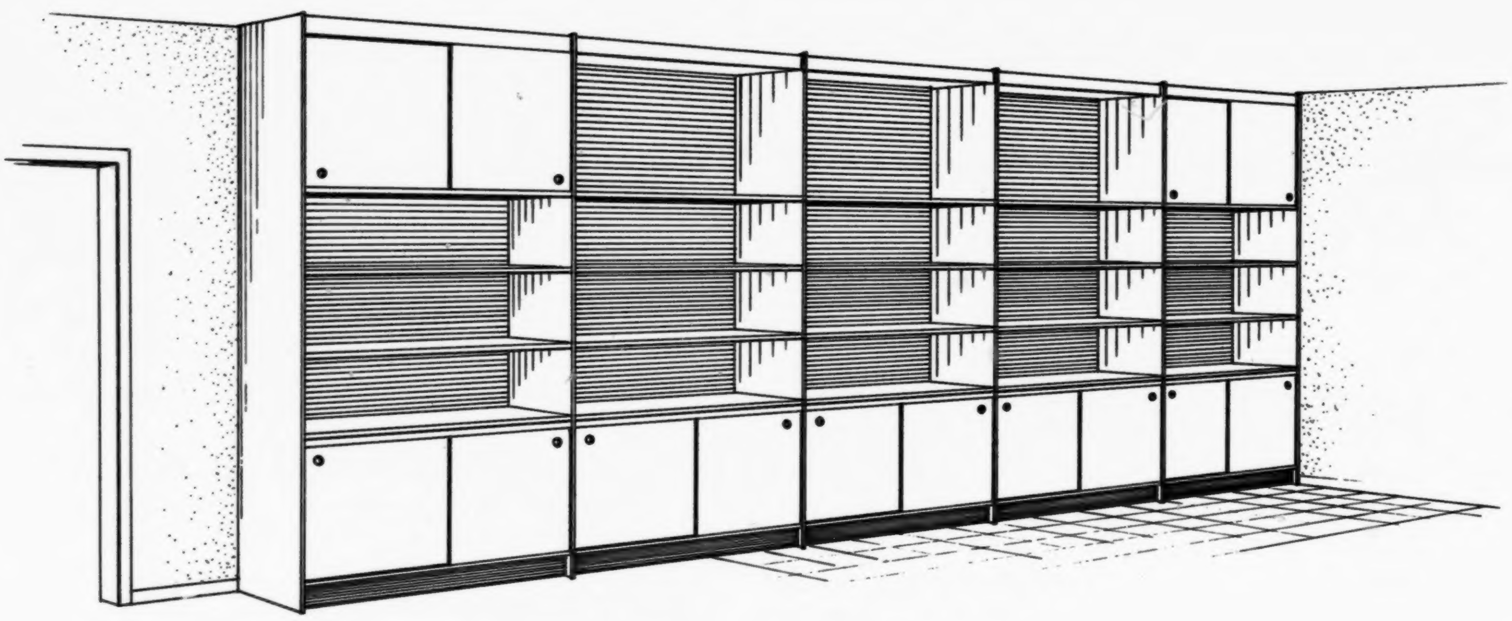


Figure 21.—A suggested layout for a combination building-materials lecture room and projection room. Screen can be quickly pulled down near the chalkboard for showing films. (See figure 22 for suggested cabinetwork to display sample building materials.)



SUGGESTED CABINETWORK FOR ARCHITECTURAL MATERIALS DISPLAY

Figure 22.—Typical cabinetwork for architectural materials display.

CONSTRUCTION MATERIALS LABORATORY

An example of a plan for this laboratory is shown in figure 23. It provides for four major kinds of activity—wood, masonry, metals, and finishing. The tools and equipment are those commonly related to building construction. Experience in the various activities should coincide with lectures given in the course on building materials and construction methods. The intent is to give students introductory practice with real materials and information on what is involved in their use. Laboratory projects should illustrate and confirm information presented in lectures, rather than develop skills in building construction trade work.

Balancing of the activities to rotate students through the various work spaces in the laboratory will need careful attention. Closely supervised instructions may be restricted to only two or three spaces at any one time, but the whole laboratory requires continual surveillance by an alert instructor. The entire laboratory can be supervised by one instructor, however, because of glass partitions, even if groups of students are working in each of the four different spaces. Large projects can be easily taken out-of-doors through the large doors and completed on the concrete apron or nearby grounds. However, during bad weather, work projects can and must be conducted inside.

Provision must be made for adequate storage of all tools and equipment so they can be easily accounted for. Adequate time must be allotted to the instructor for the continual maintenance of all tools, equipment, and supplies.

SURVEYING EQUIPMENT STORAGE ROOM

Careful attention should be given to the design of storage areas for surveying equipment. Most of the equipment is costly and must therefore be cared for carefully. Moreover, a properly laidout room will save much time in issuing equipment for surveying crews and checking it back in. Unless the equipment is continually inspected for possible damage when it is checked in after laboratory exercises, full life expectancy of the equipment cannot be realized.

A workable layout such as that shown in figure 24 provides a checkout counter near one end of the room with one door for students to enter, and another door near the other end of the counter through which they leave after receiving their equipment. Shelves placed on the wall between the doors provide a handy place for students to set textbooks, field books, and other gear while they are checking out the equipment.

Cabinets and racks must be provided for storing equipment in an organized way. Notice that an A-frame storage rack (see figures 25 and 26) in the center of the room is convenient for storing tripods and rods and is still accessible.

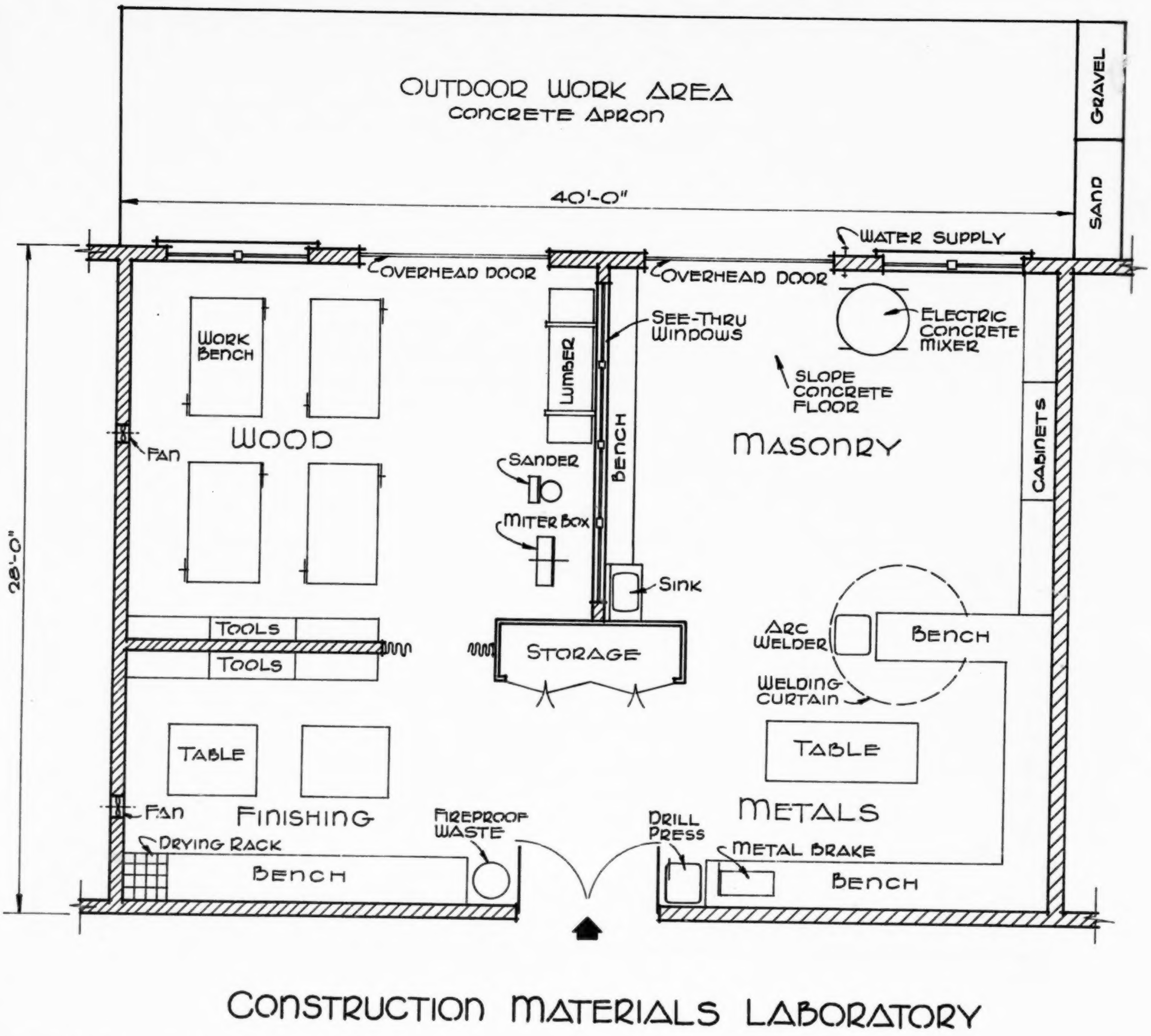


Figure 23.—Construction materials laboratory.

GENERAL STORAGE ROOM

The department should have ample provision for storage of miscellaneous items, such as examples of student drawings, teaching aids, and other equipment necessary to the program. Most of the equipment and supplies can be stored in a room equipped with wide shelving. The shelving should be designed to accommodate the equipment.

DISPLAYING STUDENT WORK

Attractive display of student work in an architectural and building construction technology department must be considered. The display of student work and an occasional display of professional work are effective means of motivating students. Large cork boards can be used if placed in prominent areas of halls or passageways. Tables should be reserved for display of models and three-dimensional exercises; in order to maintain interest, exhibits should be continually kept up-to-date with current work.

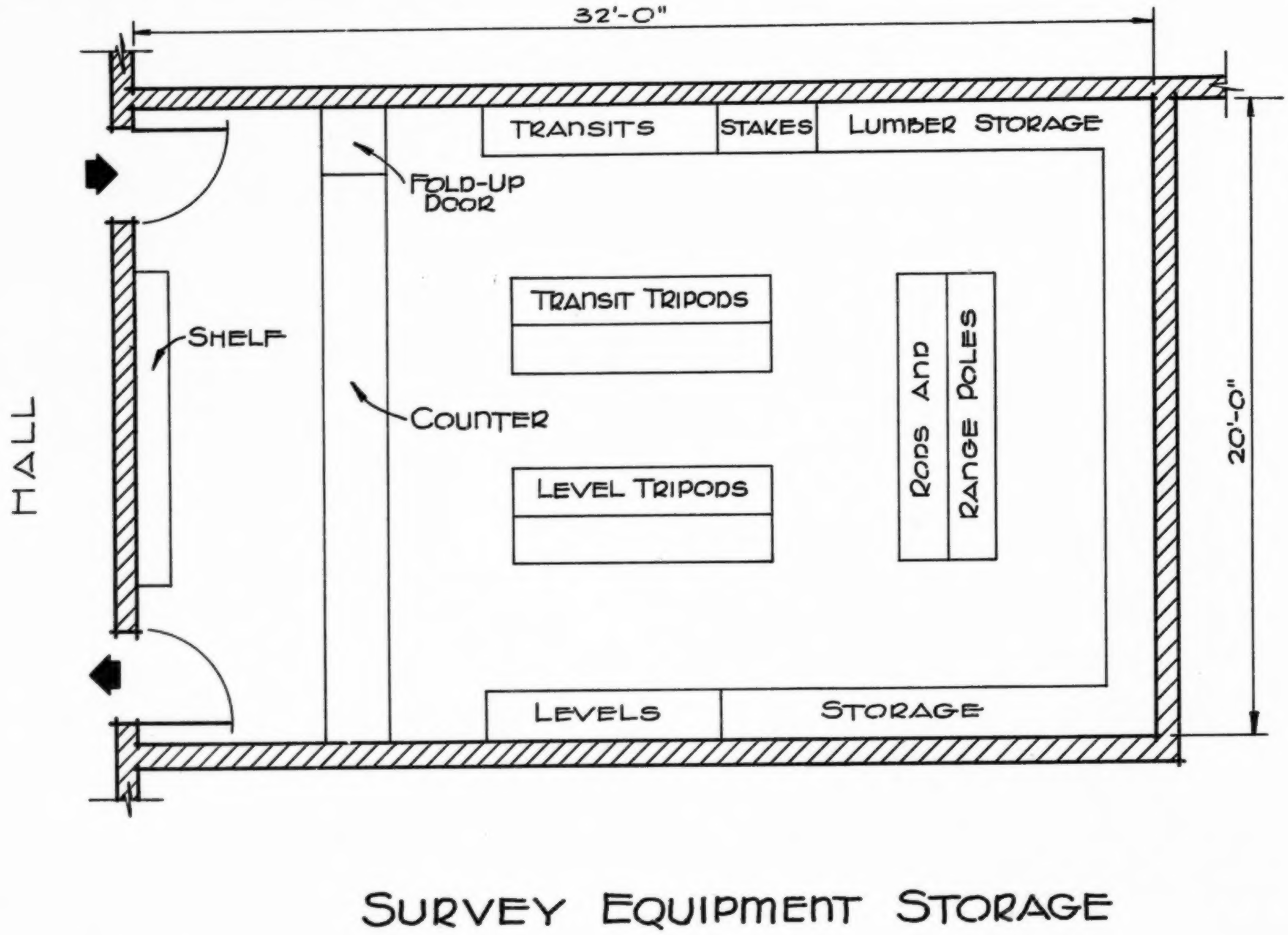


Figure 24.—Survey equipment storage room.

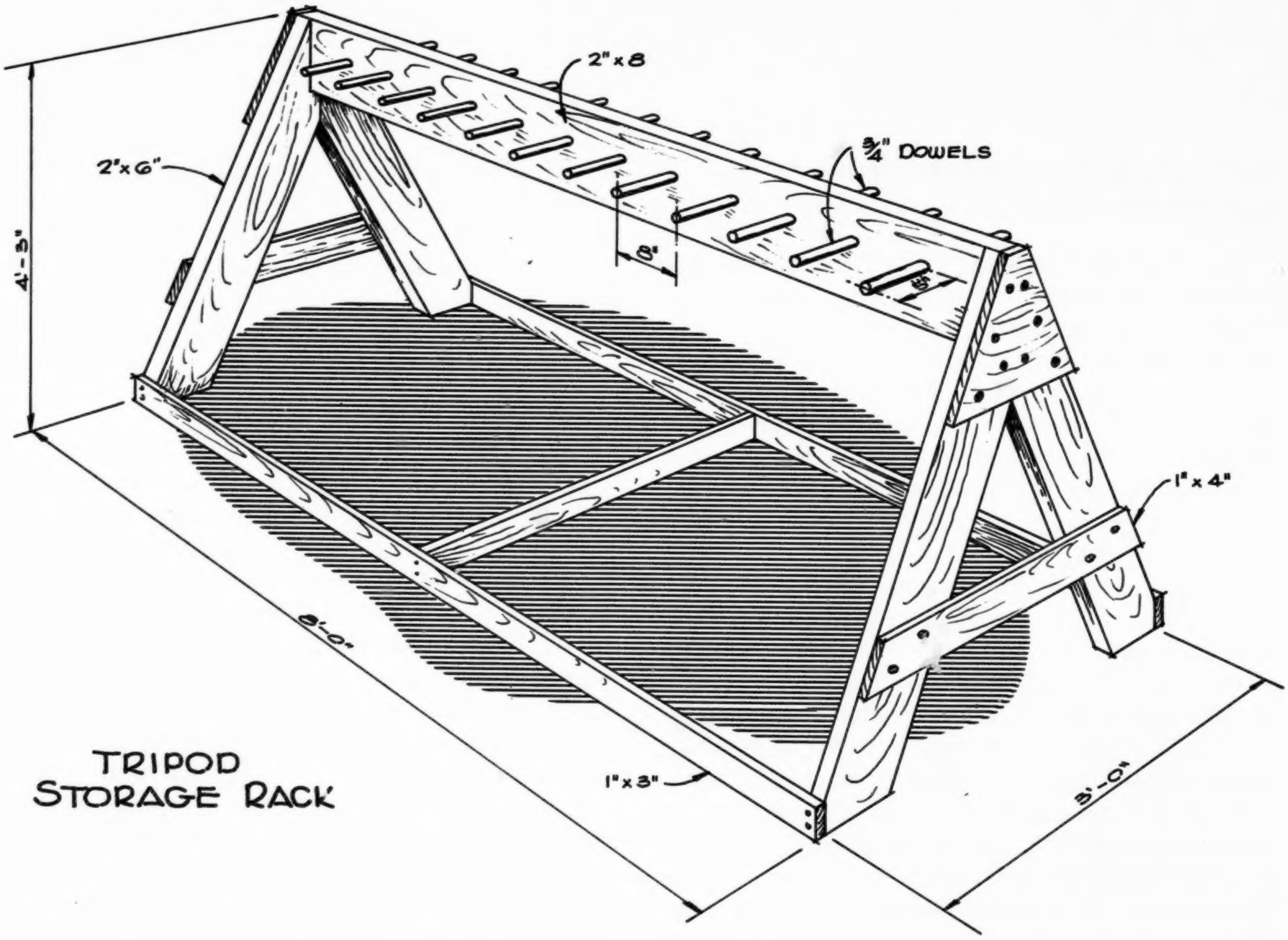


Figure 25.—A storage rack for transit tripods.

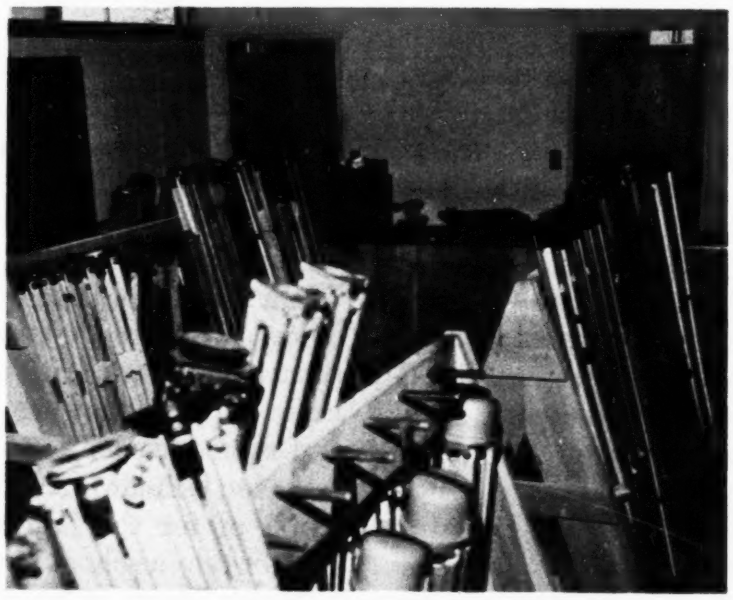


Figure 26.—This illustrates the use of tripod storage racks such as shown in figure 25.

Equipping The Laboratories and Their Costs

The cost of equipping an architectural and building construction department is not excessive. Ideally, a program should start with fully equipped laboratories; but if necessary, the required laboratories can be equipped as the program develops; the outlay of funds before the first year of the program is thus reduced to a minimum the first year, and the costs of equipment needed for the second year can be spread over the first year's operation.

Experience has shown that the department head or one of the technical specialty instructors is the best qualified person to make final decisions on the selection of laboratory equipment. His background in the technical specialty will usually prevent costly mistakes which often occur when nontechnical employees select or buy equipment.

Surplus equipment, from either private or public organizations, can be an important source of good materials and hardware for equipping laboratories. Government surplus property may often be an especially attractive source of either standard or specialized components, units, assemblies, mechanisms, instruments, and systems—the cost of which usually is only a small fraction of the cost when new. Educational institutions are high on the priority list of agencies to which government surplus property is made available.

Acquisition of surplus property within the States must be made through State agencies for surplus property. Most such State agencies maintain one or more distribution centers at which authorized representatives of eligible schools or school systems select materials for educational use. Usually one or more officials of a school or school system are designated as authorized representatives. Technical educators should communicate with the authorized representative of their school or school system, if one exists, to arrange to visit their State agency's distribution center; or write to the director of their State agency for surplus property to obtain information on how to acquire equipment.

The State director of vocational and technical education in each State can provide specific information on the location of the government surplus distributing agency in his State and the name of the person in charge. Information on government surplus property may also be obtained by writing to:

Chief, Surplus Property Utilization Division
U.S. Department of Health, Education, and Welfare
Washington, D.C. 20201

Experience has shown that it is important to exercise judgment and care in acquiring surplus equipment. Specific plans for the use and sound justification for the need should be established clearly for *any* piece of surplus equipment. A careful analysis should be made of its total cost, transportation, space required, cost of installation, repair or parts replacement (if incomplete), and maintenance; and the likelihood of the equipment becoming obsolescent within a short time.

Only technically competent, responsible, and imaginative persons should select surplus equipment, and then only after a thorough on-site inspection. Such persons avoid the temptation or tendency to acquire equipment that is attractive, but obsolete, irrelevant, bulky, or in excessive amounts. With these precautions in mind, resourceful department heads or instructors can usually obtain testing instruments, apparatus, and other essential up-to-date equipment for their laboratories at very reasonable cost.

The estimates that follow are based on the costs of equipping architectural and building construction laboratories for 24 students, with new equipment, of good quality but not fancy. The estimates are based on the purchase price at the date of this publication. The estimates do not include costs of office furniture, conventional classrooms, and rooms or laboratories necessary to conventional basic courses. They are specifically for laboratories and rooms needed for the technical specialty. No inclusion is made for conventional firefighting equipment, or for the janitorial equipment necessary to maintain a school building.

Major items of equipment necessary for each laboratory are listed, and an estimate of their cost is given below as a gross figure with a reasonable range to reflect variations in costs of brand names and local areas. Since comparable equipment may vary in cost in various locations, individual items are not priced. Costs of equipment may vary also if purchased in larger quantities. It is suggested that at least three bids be obtained before obtaining any of the equipment. Detail prices can be provided by suppliers when purchases are to be made. Again, it is worthwhile stating that only good quality equipment should be purchased for school instruction.

Supplies that students need in the drawing laboratory are listed merely for convenience in case the institution provides these supplies for the student. In most technical schools the student provides his own supplies, even though standardized materials are used.

ESTIMATES FOR SPECIFIC FACILITIES DRAFTING LABORATORY EQUIPMENT AND SUPPLIES

Large Drafting Laboratory

Item	*Number required*
Drafting tables, 3′ x 5′ wood, adjustable basswood tops	24
Parallel bars, wood, 5′ long, plastic edges	24
Drafting stools, steel, round-top	24
Storage cabinets, steel	2
Demonstration table, wood, 4′ x 6′	1
Rostrum and stool (ea.)	1
Coatracks	2
Wastepaper basket	1
Blackboard, 3′ x 18′	1
30°–60° triangle, 14″	24
45° triangle, 10″	24
Architect's scale, 12″ triangular	24
Civil engineer's scale, 12″ triangular	24
Irregular curves	24
Pencil pointers	24
Erasing shields	24
Sets of drawing instruments	24
Protractors	24
Adjustable triangles	24
Lettering guides	24
Dusting brushes	24
Architectural brushes	24
Erasers	24
Electric erasing machine	1
Rolls of drafting tape	24
Semi-automatic pencils	24
Sets of assorted leads	24
Rolls of sketching paper	24
Rolls of tracing paper (or cut sheets)	24
Sets of assorted sheets of drawing paper	24
Set *Sweet's Catalog Service*	1

Estimated cost—total, $7,000 to $8,500

Beginning Drafting Laboratory

Item	*Number required*
Drafting tables, 24″ x 30″	30
Drafting stools, steel	30
T-squares	30
Display table, 3′ x 6′	1
Blackboard, 3′ x 16′	1
Rostrum and stool (ea.)	1
Platform	1
Steel cabinets	2
Coatracks	2
Cork display board	1
Wastepaper basket	1
Assorted supplies of paper, as required	1

Estimated cost—total, $5,000 to $6,000

Model Building Laboratory

Item	*Number required*
Model building tables	4
Low stools, steel	24
Blackboard, 3′ x 10′	1
Workbench, with vise	1
Set of toolroom racks and cabinets	1
Power disk sander	1
Power belt sander, 6″	1
Table saw	1
Drill press	1
Jigsaw	1
Waste receptacle	1
Sets of model-building hand tools, each including	4
Stanley cutting knives	3
Framing square	1
Back-band hand saw	1
Try square	1
Coping saw	1
Shears	1
Architect's scale	1
Metal straight-edge	1
Small hammer	2
Paint brushes, 1″	2
Sheets sandpaper, medium	1
Tweezers	1
Sharpening stone	1
Mitering saw	1

Estimated cost—total, $3,500 to $4,500

Reproduction Room

Item	*Number required*
Blueline reproduction machine	1
Spirit duplicator ("Ditto" machine)	1
Mimeograph machine	1
Paper cutter, 24″	1
Worktable	1
Storage cabinet	1
Large paper shears	1
Initial supply of blueline paper	1

Estimated cost—total, $4,000 to $5,500

Building Materials Display and Lecture Room

Item	*Number required*
Movie projector, 16 mm	1
Roll-down screen, 6′ x 8′	1
Overhead projector	1
Tablet armchairs	48
Blackboard, 3′ x 16′	1
Rostrum	1
Demonstration slide rule, 7′	1
Set of adjustable shelving and cabinets	1
Coat racks	2
Set blackout screens	1

Estimated cost—total, $2,500 to $3,000

Construction Materials Laboratory (Wood Station)

Item	*Number required*
Woodworking benches, w/vises	4
Tool cabinets	1
Lumber storage rack	1
Disk sander	1
Miter box	1
Nail hammers, 16 oz	6
Nail hammers, 13 oz	6
Ratchet braces and assorted bit sets	2
Wood chisel sets, assorted sizes	2
Try squares, 10″	6
Framing squares, 24″	6
Level, 24″	1
Steel rules, 12″	6
Nail set, assorted sizes	2
Screwdriver sets, assorted sizes	2
Ripsaw, 5½-point	1
Crosscut saws, 10-point	6
Keyhole saw	1
Coping saws	4
Hand planes, 9″	6
Miscellaneous hand tools, set	1
Lumber and plywood supplies	
Assorted Plexiglas and other plastic materials	

Estimated cost (wood station), $2,500 to $3,000

(Masonry Station)

Item	*Number required*
Workbench, built-in	1
Cabinets, storage	1
Concrete mixing machine, electric	1
Rubber hose, 50 ft	1
Shovels, square point	3
Trowels, bricklayers, 11″	6
Hammers, bricklayers	3
Brick chisels, 4″	3
Jointing tools, brick pointing	3
Levels, 24″	3
Steel finishing trowels	6
Wood floats, 12″	6
Level, 48″	1
Edging tools, concrete	3
Mortar mixing box	1
Steel tapes, 50 foot	2
Bricklayers' rules	6
Mixing hoe	1
Miscellaneous equipment set	1
Supplies, cement, mortarmix, aggregate, brick, and block.	

Estimated cost (masonry station), $1,500 to $2,000.

(Metal Station)

Item	*Number required*
Metal working table	1
Bench and cabinet work	1
Sheetmetal brake, bench model	1
Arc welder, portable, with screen	1
Set of hand tools for welder	1
Drill press, floor model	1
Electric soldering tool	1
Bench vise, machinist's	1
Hammers, ball peen	6
Sheet metal shears	6
Steel squares, 24″	2
Hack saws	6
Scratch awls	6

Item	*Number required*
Pliers, assorted sizes	6
Steel rules, 24"	3
Steel rules, 12"	3
Pipe vise	1
Pipe cutter and reamer	1
Pipe threading tool, assorted dies	1
Pipe wrenches, large	2
Pipe wrenches, medium	2
Hand torch, butane	1
Hand files	6
Screwdrivers, assorted	6
Adjustable wrenches	3
Riveting tool set	1
Metal supplies	

Estimated cost (metal station), $2,500 to $3,000

(Finishing Station)

Item	*Number required*
Finishing tables	2
Storage cabinets	1
Bench	1
Drying rack	1
Fireproof waste receptacle	1
Putty knives, 1¼" wide	6
Putty knives, 4" wide	6
Glass cutters	3
Paint brush sets, assorted sizes	4
Brush storage container	2
Steel rules, 24"	3
Mixing pans and containers	6
Sandpaper and steel wool supplies	
Miscellaneous equipment	1
Supplies, other	

Estimated cost (finishing station), $1,500 to $2,000

Estimated cost for the laboratory—total, $8,000 to $10,000

Materials Testing Laboratory

Item	*Number required*
Universal testing machine, (120,000 lbs. min. capacity) and accessories	1
Rockwell hardness tester	1
Set miscellaneous strain reading equipment	1
Resistance strain indicator	1
Work tables, 30" x 18'	3
Low stools, steel	24
Blackboard, 3' x 16'	1
Demonstration counter, wood, 2' x 10'	1
Set of storage shelves	1

Estimated cost—total, $28,000 to $32,000

Surveying Equipment Storage Room (including surveying field equipment and supplies)

Built-in checkout counter	1
Rod and pole rack, wood	1
Tripod rack	1
Built-in storage cabinet	1
Steel tapes, 100', surveyor's	6
Chaining pins, 11/set	6
Range poles	6
Metallic tape, 50'	6
Plumb bobs	6
Hand axes	6
Clamp handles, for taping	6
Dumpy levels	8
Philadelphia level rods, extension type with target	8
Hand levels	8
Transits, vernier reading to 1 min.	6

Estimated cost—total, $12,000 to $14,000

General Storage Room

Item	*Number required*
Steel shelving as required	

Estimated cost—total, $500 to $1,000

Summary of Costs

The list of equipment and supplies is basic and does not include items for specialized programs or situations. In addition to the cost of basic equipment, a further sum of from $3,000 to $5,000 should be earmarked and included for the cost of installing equipment and special built-in furnishings in the various laboratories. It is assumed that a continuing budget is provided for the repair and maintenance of the laboratories in the departments.

The total cost of laboratories and equipment, excluding conventional classrooms and offices, for an architectural and building construction technology program, based upon 1969 prices, may be estimated as follows:

Laboratory Facility	*Estimated Cost*
Large drafting laboratory equipment and supplies	$7, 000 to $8, 500
Beginning drafting laboratory	5, 000 to 6, 000
Model-building laboratory	3, 500 to 4, 500
Reproduction room	4, 000 to 5, 500
Building materials display and lecture room	2, 500 to 3, 000
Construction materials laboratory	8, 000 to 10, 000
Materials testing laboratory	28, 000 to 32, 000
Surveying equipment and storage room	12, 000 to 14, 000
General storage	500 to 1, 000
Installing of various equipment	3, 000 to 5, 000
Total estimated cost of laboratory equipment and supplies	$73, 500 to $89, 500

The foregoing estimates do not provide for the cost of the building itself; if it is constructed for the program, the cost may be roughly calculated at from $12 to $15 per square foot of unfurnished laboratory space.

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APPENDIX A

Societies and Agencies Pertinent to the Education of Architectural and Building Construction Technicians

Some of the professional, scientific, and technical societies or associations concerned with architectural and building construction engineering and its applications are useful sources of instructional information and reference data.

The selected list which follows is not a complete listing of all such organizations; and inclusion does not imply special approval of an organization, nor does omission imply disapproval of an organization. Details regarding local chapters or sections of societies have been omitted.

Teachers and others desiring information from the organizations listed below should address their inquiries to "The Executive Secretary" of the organization. A request for information about the organization and its services or for specific information can usually be answered promptly by them.

AMERICAN CONCRETE INSTITUTE, Post Office Box 4754, Redford Station, Detroit, Mich. 48219.

History: Founded 1905: A technical society of engineers, architects, contractors, educators, and others interested in its purpose.

Purpose: To improve techniques of design, construction, and maintenance of concrete products and structures.

Total membership: 11,600.

Publications: *Journal of the ACI*, monthly.

AMERICAN INSTITUTE OF ARCHITECTS, 1735 New York Avenue NW., Washington, D.C. 20006.

History: Founded 1857: Professional society of architects. Absorbed (1889) Western Association of Architects. Maintains library of 12,000 volumes.

Purpose: Grants honor awards, scholarships, and fellowships. Works through commissions which coordinate and review committee activities in their respective areas of responsibility. Sponsors American Institute of Architects Foundation. Affiliated with National Institute for Architectural Education; Producers Council.

Total membership: 15,270.

Publications: *AIA Journal*, monthly.

AMERICAN IRON AND STEEL INSTITUTE, 150 East 42nd Street, New York, N.Y. 10017.

History: Founded 1855; from 1855-65—American Iron Association; from 1865 to 1908—American Iron and Steel Association: A nonprofit organization of the iron and steel industry of the Western Hemisphere, engaging in activities of common interest to all members of the industry.

Purpose: To promote the interests of the iron and steel industry, to collect statistics and other information concerning the industry, to engage in investigation and research, to provide a forum for the exchange of information and discussion of problems relating to the industry, and to promote the use of iron and steel.

Total membership: Eighty-three company members and over 2,800 individual members.

Publications: Numerous publications available upon request.

AMERICAN PLYWOOD ASSOCIATION, 1119 A. Street, Tacoma, Wash. 98400.

History: Founded 1936; formerly Douglas Fir Plywood Association. Members are manufacturers of fir plywood and allied products. Sponsors Plywood Research Foundation and Plywood Fabricator Service.

Purpose: Conducts trade promotion through advertising, publicity, merchandising, and field promotion; maintains quality control in accordance with the commercial standards and grade techniques.

Total membership: 118.

Publications: *Production Report*, weekly; *Forecast of Demand*, monthly.

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1916 Race Street, Philadelphia, Pa. 19103.

History: Founded 1898: Engineers, scientists, and skilled technicians holding membership as individuals or as representatives of business firms, government agencies, educational institutions, laboratories.

Purpose: To promote the knowledge of materials of engineering, and the standardization of specifications and testing methods. Sponsors more than 125 research projects: issues various awards for research and significant contribution in this area. Has developed standard test methods, specifications, and recommended practices now in use.

Total membership: 11,800.

Publications: *Materials Research and Standards Journal*, monthly; *Proceedings*, annual; *Yearbook; Index to Standards*, annual; *Book of Standards*, annual. Numerous technical papers and reports.

CONSTRUCTION SPECIFICATIONS INSTITUTE (CSI), 632 Dupont Circle Building, Washington, D.C. 20006.

Ronald S. Ryner, Executive Director

Founded: 1948—Persons who are concerned with the specifications and documents used in connection with the design, construction, maintenance, and equipment for construction projects; includes architects, professional engineers, teachers and research workers in architectural and engineering fields, representatives of architects and engineers who are supervising construction projects, specification writers, building maintenance engineers, technical representative of nonprofit organizations of the construction industry.

Total membership: 5,300; staff 6 local groups, 50.

Publications: *Construction Specific*, monthly.

Convention/Meeting: Annual.

FOREST PRODUCTS LABORATORY, U.S. Department of Agriculture, Madison, Wis. 53700.

NATIONAL FOREST PRODUCTS ASSOCIATION (formerly National Lumber Manufacturers' Association), 1619 Massachusetts Avenue, Washington, D.C. 20036.

History: Founded 1902: Federation of 17 regional lumber manufacturers' associations, representing major regional, species, and product groups in the industry.

Purpose: To promote use of forest products through National Wood Promotion Program; conservation and renewal of forest properties and uses of wood and wood products through its affiliated Timber Engineering Company. Sponsors Economic Council of the Lumber Industry, which considers economic problems of the industry on a national basis.

Total membership: 17.

Publications: *Lumber Letter*, weekly; *Promotion Progress; Monthly Statistical Report of Lumber and hardwood Flooring;* also publishes booklets, pamphlets for home owners.

PORTLAND CEMENT ASSOCIATION, 33 W. Grand Avenue, Chicago, Ill. 20600.

History: Founded 1916: Members are manufacturers of portland cement. Gives lectures and demonstrations for architects, contractors, and others; provides information to schools, colleges, farm organizations, and technical groups; assists with instruction on improved methods of concrete design and construction.

Purpose: To improve and extend the uses of portland cement and concrete through scientific research and engineering field work.

Total membership: 75; staff: 750.

Publications: 400 booklets which are circulated, along with motion picture film and other materials on uses of cement and concrete in road paving, structures, conservation, housing and farm buildings.

SOUTHERN PINE ASSOCIATION, Post Office Box 1170, National Bank of Commerce Building, New Orleans, La. 70100.

History: Founded 1914: Members are manufacturers of Southern pine lumber. Affiliated with Southern Pine Inspection Bureau; Southern Pine Industry Committee.

Purpose: To conduct research programs in product improvement, timber, design, gluing of lumber, exterior and interior finishes, wood quality effects of spacing in plantations. Promotes public education in improved land use in protection, growing and harvesting trees.

Total membership: 152.

Publications: Manual and textbook on timber engineering and specifications.

UNITED STATES OF AMERICAN STANDARDS INSTITUTE, 10 East 40th Street, New York, N.Y. 10016.

History: Founded 1918; formerly the *American Standards Association.* Composed of industrial firms, trade associations, technical societies, consumer organizations, and government agencies.

Purpose: Serves as a clearinghouse on nationally coordinated voluntary safety, engineering and industrial standards. Gives status as "USA Standard" to projects developed by agreement from all groups concerned in such areas as definitions, terminology, symbols, and abbreviations; materials, performance characteristics, procedure and methods of rating; methods of testing and analysis; size, weight, volume and rating; practices; safety; health; and building construction. Provides information on foreign standards and represents United States interests in international standardization work.

Total membership: 2,300.

Publications: *Magazine of Standards*, monthly; *Newsletter*, monthly; *Proceedings*, annual; individual standards.

WEST COAST LUMBERMEN'S ASSOCIATION, 1410 S. W. Morrison Street, Portland, Oreg. 97205.

History: Founded 1911: Mills and fabricating and treating plants in the Douglas fir region that use Douglas fir, West Coast hemlock, Western red cedar, White fir, and Sitka spruce.

Purpose: To bring to the general public knowledge of the manufacture of different species of lumber through advertising and promotion; carloading; car supply; general maritime; lumber costs and reports; public relations; traffic and insurance.

Total membership: 180.

Publications: Technical reports.

APPENDIX B

Suggestions on Library Content for the Technology

The library content may be classified as basic encyclopedic and reference index material, reference books pertinent to architectural and building construction technology, periodicals and journals, and visual aids.

Encyclopedic and Reference Index Material.

This part of the library content is basic in that it contains the broadly classified and organized cataloging of all available information pertinent to the objectives the library serves and the program it supports.

The following is a typical list of general reference material that might be found in a publicly controlled technical institute. Though many are general, all of these references have some bearing on architectural and building construction technology. Some or all of these might appropriately be a part of the library which supports an architectural and building construction technology program. This list is not complete, since it is presented as an example. In ordering any of the references, specify the latest edition.

AMERICAN COLLEGE DICTIONARY: Random House, Inc., 457 Madison Avenue, New York, N.Y. 10022.

APPLIED SCIENCE & TECHNOLOGY INDEX: H. W. Wilson Co., 950 University Avenue, Bronx, N.Y. 10452.

ASTM STANDARDS: American Society for Testing Materials, 1916 Race Street, Philadelphia, Pa. 19103.

BIBLIOGRAPHY INDEX, THE: H. W. Wilson Co., 950 University Avenue, Bronx, N.Y. 10452.

BUSINESS PERIODICALS INDEX: H. W. Wilson Co., 950 University Avenue, Bronx, N.Y. 10452.

CHEMICAL ABSTRACTS: American Chemical Society, 1155 16th Street N.W., Washington, D.C. 20006.

CHEMICAL INDUSTRY FACTS BOOK, THE: Manufacturing Chemists Association, Inc., 1825 Connecticut Avenue, Washington, D.C. 20009.

COLLIERS ENCYCLOPEDIA: Collier-Macmillan Library Service Division, 60 Fifth Avenue, New York, N.Y. 10011.

COMMERCIAL ATLAS AND MARKETING GUIDE: Rand McNally & Co., Box 7600, Chicago, Ill. 60680.

CUMULATIVE BOOK INDEX: H. W. Wilson Co., 950 University Avenue, Bronx, N.Y. 10452.

DICTIONARY OF APPLIED CHEMISTRY: J. Thorpe, John Wiley & Sons, Inc., 605 3d Avenue, New York, N.Y., 10016.

DICTIONARY OF ARCHITECTURAL ABBREVIATIONS, SIGNS AND SYMBOLS: Odyssey Press, 55 Fifth Avenue, New York, N.Y. 10003.

ENCYCLOPAEDIA BRITANNICA: Encyclopaedia Britannica, Inc., 425 N. Michigan Avenue, Chicago, Ill. 60611.

ENCYCLOPEDIA AMERICANA, THE: Americana Corporation, 575 Lexington Avenue, New York, N.Y. 10022.

ENCYCLOPEDIA OF CHEMICAL REACTIONS: C. A. Jacobson and Clifford A. Hampel, Reinhold Publishing Corp., Book Division, 430 Park Avenue, New York, N.Y. 10022.

ENCYCLOPEDIA OF CHEMISTRY, THE: Clark and Hawley, Reinhold Publishing Corp., Book Division, 430 Park Avenue, New York, N.Y. 10022.

ENCYCLOPEDIA OF MODERN ARCHITECTURE: H. N. Abrams, 6 W. 57th Street, New York, N.Y. 10019.

ENCYCLOPEDIA OF THE SOCIAL SCIENCES: The Macmillan Co., 60 Fifth Avenue, New York, N.Y. 10011.

ENCYCLOPEDIA OF WORLD ART: McGraw-Hill Book Co., Inc., 330 W. 42d Street, New York, N.Y. 10036.

ENCYCLOPEDIC DICTIONARY OF PHYSICS: J. Thewlis, Pergamon Press, 44–91 21st Street, Long Island City, N.Y. 11101.

ENGINEERING INDEX: Engineering Index, Inc., 345 E. 47th Street, New York, N.Y.

ENGINEERING MATERIALS HANDBOOK: Charles L. Mantell, McGraw-Hill Book Co., Inc., 330 W. 42d Street, New York, N.Y. 10036.

HANDBOOK OF CHEMISTRY AND PHYSICS: Chemical Rubber Publishing Co., 2310 Superior Avenue NE., Cleveland, Ohio 44114.

INTERNATIONAL CRITICAL TABLES: McGraw-Hill Book Co., Inc., 330 W. 42d Street, New York, N.Y. 10036.

INTERNATIONAL DICTIONARY OF PHYSICS AND ELECTRONICS: D Van Nostrand Co., Inc., Princeton, N.J. 08540.

LABOR POLICY AND PRACTICE: Bureau of National Affairs, Inc., 1231 24th Street, Washington, D.C. 20037.

LIBRARY OF CONGRESS CATALOG: U.S. Library of Congress, Washington, D.C. 20000.

MANUAL FOR PROCESS ENGINEERING CALCULATIONS: McGraw-Hill Book Co., Inc., 330 W. 42d Street, New York, N.Y. 10036.

McGRAW-HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY: McGraw-Hill Book Co., Inc., 330 W. 42d Street, New York, N.Y. 10036.

METALS HANDBOOK: American Society for Metals, Technical Book Dept., Novelty, Ohio 44072.

MOODY'S INDUSTRIAL MANUAL: Moody's Investor's Service, 99 Church Street, New York, N.Y. 10007.

NUCLEAR SCIENCE ABSTRACTS: U.S. Atomic Energy Commission, Washington, D.C. 20000.

OXFORD ENGLISH DICTIONARY: Oxford University Press, Inc., 417 Fifth Avenue, New York, N.Y. 10016.

POOR'S REGISTER OF CORPORATIONS, DIRECTORS, AND EXECUTIVES: Standard and Poor's Corporation, 345 Hudson Street, New York, N.Y. 10014.

READER'S GUIDE TO PERIODICAL LITERATURE, THE: H. W. Wilson Co., 950 University Avenue Bronx, N.Y. 10452.

RESEARCH AND DEVELOPMENT ABSTRACTS: U.S. Atomic Energy Commission, Washington, D.C. 20000.

SCIENTIFIC AND TECHNICAL SOCIETIES OF THE UNITED STATES AND CANADA: National Academy of Sciences, National Research Council, 2101 Constitution Avenue NW., Washington, D.C. 20000.

STATISTICAL ABSTRACT OF THE U.S.: Department of Commerce, Washington, D.C. 20402.

SWEET'S INDUSTRIAL CONSTRUCTION FILE: Sweet's Catalog Service, F. W. Dodge Corp., 119 W. 40th Street, New York, N.Y. 10014.

TEMPERATURE—ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY: American Institute of Physics, 335 East 45th Street, New York, N.Y. 10017.

THOMAS REGISTER: Thomas Publishing Co., 461 Eighth Avenue, New York, N.Y. 10001.

VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA: D. Van Nostrand Co., Inc., 120 Alexander Street, Princeton, N.J. 08540.

WEBSTER'S INTERNATIONAL DICTIONARY: G. & C. Merriam Co., 47 Federal Street, Springfield, Mass. 01102.

WELDING HANDBOOK: American Welding Society, 345 East 47th Street, New York, N.Y. 10017.

WOOD HANDBOOK: U.S. Department of Agriculture, Washington, D.C. 20250.

Technical Journals, Periodicals, and Trade Magazines

The importance of this part of the library content must be reemphasized. The publications listed represent the most authoritative, most recent, and most thorough presentation of new information and new applications of principles to a given specific area of applied science. It is essential that both instructors and students make frequent and systematic use of such literature to keep their technological information up to date.

Careful selectivity should be exercised in retaining, binding, or microfilming periodicals for permanent library use. Some represent important reference material which may be used for many years. However, some, especially the trade journals, should not be bound for permanent reference material because the important material which they contain will usually become a part of a handbook or textbook or be presented in a more compact and usable form within a year or two.

The following is a typical list of technical journals, periodicals, and trade magazines which would be desirable in the library. This list is given as an example which may suggest appropriate publications to those who are concerned with this type of content for a library supporting architectural and building construction technology teaching programs.

AIR CONDITIONING, HEATING AND VENTILATING: Industrial Press, 200 Madison Avenue, New York, N.Y. 10016.

AMERICAN BUILDER: Simmons-Boardman Publishing Corp., 30 Church Street, New York, N.Y. 10007.

AMERICAN CONCRETE INSTITUTE JOURNAL: Box 4754, Redford Station, Detroit, Mich. 48219.

AMERICAN HOME: Curtis Publishing Co., Independence Square, Philadelphia, Pa. 19105.

AMERICAN INSTITUTE OF ARCHITECTS JOURNAL: The Octagon, 1735 New York Avenue NW., Washington, D.C. 20006.

AMERICAN ROOFER AND BUILDING IMPROVEMENT CONTRACTOR: Shelter Publications, 180 N. Wacker Drive, Chicago, Ill. 60606.

ARCHITECT AND BUILDING NEWS: Iliffe Technical Publications, Ltd., Dorset House, Stamford Street, London S.E.1, England.

ARCHITECTURAL FORUM: American Planning and Civic Association, 111 W. 57th Street, New York, N.Y. 10019.

ARCHITECTURAL RECORD: McGraw-Hill Book Co., Inc., 330 W. 42nd Street, New York, N.Y. 10036.

ASHRAE JOURNAL: HEATING, REFRIGERATION & AIR CONDITIONING: 345 E. 47th Street, New York, N.Y. 10017.

BETTER HOMES AND GARDENS: Meredith Publishing Company, 1716 Locust Street, Des Moines, Iowa 50303.

BUILDING CONSTRUCTION: Industrial Publications, Inc., 5 S. Wabash Avenue, Chicago, Ill. 60603.

BUILDING ENGINEER: Building Press, Ltd., 7 Chesterfield Gardens, Curzon Street, London W.1, England.

BUILDING RESEARCH: (Building Research Institute) 1725 DeSales Street, NW., Washington, D.C. 20036.

BUSINESS WEEK: McGraw-Hill Book Co., Inc., 330 W. 42nd Street, New York, N.Y. 10036.

CONCRETE CONSTRUCTION: Concrete Construction Publications, Inc., Box 444, Elmhurst, Ill. 60126.

CONSUMER REPORTS: Consumers Union of U.S., Inc., 256 Washington Street, Mount Vernon, N.Y. 10550.

CONSTRUCTION REVIEW: (U.S. Department of Commerce) Superintendent of Documents, Washington, D.C. 20402.

CONSTRUCTION SPECIFIER: Specifications Institute, Inc., Dupont Circle Building, Washington, D.C. 20006.

CONSTRUCTION WORLD: Mitchell Press, Ltd., Box 6000, Vancouver, British Columbia, Canada.

CONSTRUCTOR; THE MANAGEMENT MAGAZINE OF THE CONSTRUCTION INDUSTRY: Magazine Publishing Division, Reuben H. Donnelley Corporation, 466 Lexington Avenue, New York, N.Y. 10017.

CONTRACTOR NEWS: Hagan Publications, Inc., Bloomfield Avenue, Montclair, N.J. 07042.

CONTRACTORS AND ENGINEERS MAGAZINE: Buttenheim Publishing Corp., 757 Third Avenue, New York, N.Y. 10017.

ENGINEERING AND CONSTRUCTION WORLD: 757 Third Avenue, New York, N. Y. 10017.

ENGINEERING NEWS-RECORD: McGraw-Hill Book Co., Inc., 330 W. 42nd Street, New York, N.Y. 10036.

ENGINEERING AND CONTRACT RECORD: Hugh C. MacLean Publications, Ltd., 1450 Don Mills Road, Don Mills, Ontario, Canada.

FORTUNE: Time, Inc., 540 N. Michigan Avenue, Chicago, Ill. 60611.

HARVARD BUSINESS REVIEW: Harvard University, Graduate School of Business Administration, Soldiers Field, Boston, Mass. 02163.

HOUSE AND HOME: McGraw-Hill Book Co., Inc., 330 W. 42nd Street, New York, N. Y. 10036.

HOUSE BEAUTIFUL: Hearst Corporation, 250 W. 55th Street, New York, N. Y. 10019.

IRON AND STEEL ENGINEER: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pa. 15222.

MATERIALS IN DESIGN ENGINEERING: Reinhold Publishing Corporation, 430 Park Avenue, New York, N.Y. 10022.

MATERIALS RESEARCH AND STANDARDS: American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.

MODERN STEEL CONSTRUCTION: American Institute of Steel Construction, Inc., 101 Park Avenue, New York, N.Y. 10017.

PRESTRESSED CONCRETE INSTITUTE JOURNAL: 205 W. Wacker Drive, Chicago, Ill. 60606.

PROGRESSIVE ARCHITECTURE: Reinhold Publishing Corp., 430 Park Avenue, New York, N.Y. 10022.

SCIENCE NEWS: Science Service, Inc., 1719 N. Street NW., Washington, D.C. 20006.

SCIENTIFIC AMERICAN: 415 Madison Avenue, New York, N.Y. 10017.

STRUCTURAL CONCRETE: 14 Howick Place, London S.W.1, England.

TILE AND ARCHITECTURAL CERAMICS MAGAZINE: Wilson-Loveton Publications, 2900 Rowena Avenue, Los Angeles, Calif. 90039.

WOOD AND WOOD PRODUCTS: Vance Publishing Corp., 59 E. Monroe Street, Chicago, Ill. 60603.

The Book Collection

The American Library Association states that "a 2-year institution of up to 1,000 students (full-time equivalent) cannot discharge its mission without a carefully selected collection of at least 20,000 volumes, exclusive of duplicates and textbooks. Institutions with broad curriculum offerings will tend to have larger collections; an institution with a multiplicity of programs may need a minimum collection of two or three times the basic figure of 20,000 volumes. The book holdings should be increased as the enrollment grows and the complexity and depths of course offerings expand. Consultation with many junior college librarians indicates that for most, a convenient yardstick would be the following: The bookstock should be enlarged by 5,000 volumes for every 500 students (full-time equivalent) beyond 1,000."

At the initiation of an architectural and building construction technology program, the head of the program and the librarian should review the current pertinent reference books available and list books to be placed in the library as regular reference material. A recommended policy is to place in the library only those reference books which are not a part of the regular textbook material for the various architectural and building construction technology courses.

At the beginning of an architectural and building construction technology program, the library should contain at least 200 or 300 reference books on various aspects of architectural and building construction technology and its related fields. Beyond the initial 200 or 300 books there should be regular and systematic additions to the reference materials in the library supporting the technology from year to year, and eventually a weeding out of those references which have become obsolete.

Visual Aids

The procedure outlined above for the acquisition of books pertinent to the architectural and building construction technology program is also suggested for placing the visual aids in the library. Both the librarian and the head of the program should review and evaluate visual aids materials as they become available; and those which are considered appropriate should be borrowed for special use or purchased for regular use.

In addition to the visual aids for teaching physical science principles, there are valuable films and other pertinent materials showing research or production which should be used selectively in teaching architectural and building construction technology.

U.S. GOVERNMENT PRINTING OFFICE: 1969 O-352-883